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GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, DIRECTOR.

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MAPS ACCOMPANYING THIS REPORT.

I. Geological Map of the Pictou coal-field in the Province of Nova Scotia, by Sir William E. Logan, F.R.S., and Edward Hartley, F.G.S. Scale one inch to one mile. Engraved on copper and printed in colours.

II. Geological Map of Lower Silurian rocks between the Chaudière and Trois Pistoles Rivers in the Province of Quebec, by Mr. James Richardson. Scale eight miles to one inch. Lithographed and printed in seven colors and tints.

III. Geological Map showing the distribution of the rock formations in parts of the Counties of Peterborough, Hastings, Addington and Frontenac, in the Province of Ontario, by Mr. Henry G. Vennor. Scale four miles to one inch. Lithographed and printed in four colors.

IV. Topographical Sketch-Map, shewing the outlines of the coal formation in Central New Brunswick, by Mr. Charles Robb. Scale eight miles to one inch. Lithographed.

V. Topographical Sketch-Map showiug the Thunder Bay and Lake Nipigon regions; to illustrate Mr. Bell's Report. Lithographed.

ERRATA.

Page 45, twenty-third line from top, for "Pictou Mining Company," *read* "Montreal and New Glasgow Coal Company."

Page 47, twelfth line from top, for "remarkable" *read* "remarkably."

Page 119, last line, for "eight inches to a mile" *read* "eight miles to an inch."

Page 143, thirteenth line from bottom, for "194 square miles" *read* "1150 square miles."

Page 181, seventeenth line from bottom, after "contact" add "with the metamorphic slates."

Page 244, twelfth line from bottom, for "following" *read* "preceding."

Page 287, sixteenth line from top, for "twice" *read* "sixty times."

Page 368, the first formula on this page should read—

$$\left(\frac{C \times 13268}{965.7}\right) + \left(\frac{H—h \times 62470}{965.7}\right) = x$$

the sign + having been accidentally omitted in printing.

Page 385, eleventh line from bottom, for "specific gravity 17.65" *read* "1.765."

Page 402, in the first line of the "GENERAL REFERENCES" of the table facing this page, for "first (right) column" *read* "first (left) column. This is corrected in 400 copies.

Page 427, third line from top, for "1860" *read* "1869."

Page 144, nineteenth line from bottom, for "southwest" *read* "southeast."

GEOLOGICAL SURVEY OFFICE,

MONTREAL, *May*, 1870.

SIR,

I have the honor to transmit to you, by request of Sir William E. Logan, F.R.S., late Director of the Geological Survey, the accompanying reports of geological explorations during the years 1866, 1867, 1868.

The Reports of Mr. Edward Hartley, of Mr. H. G. Vennor and of Mr. Charles Robb, embody also some of the results of their investigations during the season of 1869, as does likewise that of Dr. T. Sterry Hunt on iron and iron ores.

I further have the honor to transmit to you a report by Mr. James Richardson of an exploration which he made last season on the north shore of the St. Lawrence between the River Saguenay and Seven Islands Bay; and also a report by Professor R. Bell of his observations in 1869 in the Thunder Bay and the Lake Nipigon regions.

I have the honor to be,

Sir,

Your obedient servant,

ALFRED R. C. SELWYN,

Director Geological Survey.

To

THE HON. JOSEPH HOWE, M.P.

Secretary of State for the Provinces, Ottawa.


GEOLOGICAL MAP
PICTOU COALFIELD
NOVA SCOTIA

GEOLOGICAL REPORT,

FOR 1867-1868,

BY

SIR W. E. LOGAN, F.R.S., F.G.S.,

LATE DIRECTOR OF THE GEOLOGICAL SURVEY,

ADDRESSED

TO THE HONOURABLE JOSEPH HOWE, M.P.,

SECRETARY OF STATE FOR THE PROVINCES.

MONTREAL, 20*th December*, 1869.

SIR,

In May last I had the honour of presenting to the Government a Summary Report of the Progress made in the Geological Survey for the years 1867-1868, stating that there had just before that time been received from my various assistants detailed reports of their work, which would be transmitted after due study had been devoted to them. Summary Report, 1868.

Of these detailed Reports, I have now to transmit to you by the hands of my successor, Mr. A. R. C. Selwyn, the Report of myself and Mr. E. Hartley, on a portion of the coal field of Pictou, Nova Scotia; that of Mr. J. Richardson, on the Lower Silurian rocks occupying the south side of the St. Lawrence, between the Chaudière and the Rivière du Loup, in the Province of Quebec; that of Mr. H. G. Vennor, on the Laurentian rocks of the counties of Addington, Hastings and Peterboro, in Ontario; that of Mr. C. Robb, on the deposits of a region comprising chiefly the counties of York, Carleton and Victoria, in New Brunswick; and the Report of Dr. T. Sterry Hunt, on various points of geological and chemical economics. Detailed Reports.

To these Reports are added one by Mr. R. Bell, on the rocks of those islands of the Manitoulin group which are situated to the west of the Grand Manitoulin. This Report embodies the results of an exploration made in 1866, the mention of which was accidentally omitted in the Summary Report.

REPORT

ON A PART OF THE PICTOU COAL FIELD, NOVA SCOTIA.

Pictou coal field.

It has already been stated in the Summary Report of May last, that the portion of the Pictou coal field to which the time of Mr. Hartley and myself was devoted in 1868, was that which lies southward of New Glasgow, and extends several miles on each side of the East River; and that while the examination of the west side was wholly committed to Mr. Hartley, that on the east side was undertaken by myself. During the season which has just passed however, Mr. Hartley has added many facts to those previously collected by myself on this side, and these will now be embodied with my own.

Acknowledgments for assistance.

All the more important collieries in active operation near New Glasgow, are situated on the west side of the river; and it will be observed by Mr. Hartley's Report that he has had to thank the managers of these collieries for the ready assistance they universally afforded him in facilitating his work, by pointing out facts of interest, and supplying him with plans shewing under-ground excavations and topographical details on the surface. I have to express my obligations also to many persons for information, both oral and documentary, on the east as well as the west side of the river, and among them are Mr. J. B. Moore, Mr. J. P. Lawson, Mr. R. G. Haliburton, Mr. L. R. Kirby, Mr. Alex. McKay, Col. R. B. Sinclair, and Mr. J. R. Jackson. Mr. J. Rutherford, the Provincial Inspector of Mines, amongst other important information, obliged us with written descriptions of the boundaries of the various coal areas which have been leased by the Provincial Government; Mr. W. A. Hendry, Deputy Commissioner of the Crown Land Department, was so kind as to present us with a manuscript map shewing the positions of these areas and their proximate relations to some of the topographical features of the country, and Mr. H. Y. Hind supplied us with chain measurements of some of the roads and rivers. We are indebted to Mr. Jno. Weir and Mr. Alex. McBean, practical colliers, for pointing out to us various local facts of an important character with which they had become acquainted in the course of their experience; Mr. Thos. Lawther, by permission of Mr. Daniels of the Marsh Colliery, supplied us with information of the same kind, and all the farmers and inhabitants of the country were found to be most ready to assist us as far as they could.

The structure of this part of the Pictou coal field is of a very complicated character. While it is much covered with drift, it is disturbed by

undulations and broken by important faults, and to acquire even a proximate knowledge of the arrangement of its strata it was found necessary to measure, by compass and pacing, almost all public and private roads, as well as footpaths and streams. In constructing a map of the district, these have been kept in place by their relations to such of the straight boundary lines of the areas as we have had an opportunity of following; which lines, as given by Mr. Rutherford, have been assumed to be correct both in bearing and length. We have taken the coast and the navigable parts of rivers, as given on the Admiralty charts; and with a view of further binding our work together, Mr. W. B. Leather, C. E., was employed to measure, by theodolite and chain, a line from the East River to Sutherland's River, the direction being from the New Glasgow bridge on the former, by the old Merigomish road over Fraser's Mountain, to the lowest bridge on the latter. Mr. Leather has further assisted us by furnishing other lines, which he has had occasion to measure by theodolite, on both sides of the river. From these elements we have endeavored to construct a map on the scale of twenty chains to an inch. This may be presented at some future time; in the meanwhile its place is supplied by a plan on the scale of an inch to a mile, for the purpose of explaining the structure.

Measurements by Mr. W. B. Leather, C.E.

In the limited district in which we have worked there appear to be rock masses of four distinct horizons, more or less proximate. These are in ascending succession:

Series of formations.

1.—Conglomerates, quartzites and compact slates, (Devonian.)
2.—Greenish-gray and red sandstones, with conglomerates and impure limestones.
3.—Red coarse conglomerates.
4.—Productive coal measures.
$\left.\right\}$ (Carboniferous.)

1. CONGLOMERATES, QUARTZITES AND COMPACT SLATES.

On the east side of the East River, about four miles southward of New Glasgow, there rises a hill which runs eastward to Sutherland's River, and is transversely cut into two parts by the valley of McLellan's Brook. Of these the western is called Weaver's or McGregor's Mountain, while the other is termed McLellan's Mountain. Rocks of the series about to be described probably compose both hills, but it is in the last named that they have been observed by me. No exposure has been met with which gives all the members of the series in regular succession, nor is it certain which is the upper and which the lower part of what has been examined, the dip being always very obscure. On the north flank of McLellan's Mountain there is met with, belonging to this series, a dark leek-green slate, in some places compact, as on the south side of St. Mary's road, about 750

Pre-carboniferous rocks.

McGregor's Mountain.

McLellan's Mountain.

Green slates.

paces southward of the house of Mr. Donald McLean (John's son), on a small mountain stream. A similar green slate is seen on Sutherland's River, at Park's Mills, but much of it is of a scaly character; and it is conspicuous from the opaque white surface it presents when weathered.

Quartzites.

On the same side of the hill, light and dark gray or nearly black, as well as olive-green quartzites, occur in several places, and a good instance of them presents itself at the bridge over a tributary of Sutherland's River, crossing the road already mentioned about half a mile from McPherson's mills.

At the edge or brow of the hill, south of the house of Mr. Finlay McDonald (John's son), and near the mountain road, a rock of a greenish colour is composed of feldspar with fine grains of quartz; loose angular masses of an epidotic character lie about, and some of a porphyroid aspect, reddish in tint, holding epidote and disseminated small masses or crystals of white feldspar. Some angular fragments of the rock shew a purplish slate attached to them, and flakes of a bluish slate are enclosed in the rock in place. In some parts there appeared to be an obscure indication of stratification, the dip being N. 13° W. $<$ 40°* ; but the beds are so closely soldered together as to be undistinguishable except by slight differences of colour on the weathered surface. The rock here has different planes of cleavage, the underlie of one set being S. 3° E. $<$ 61°, and of another S. 63° E. $<$ 69°.

Red conglomerates of McLellan's Mountain.

In several places between this and McLellan's Brook the ridge of the hill presents a firm reddish conglomerate, with an arenaceo-feldspathic base, enveloping pebbles of various sizes up to an inch in diameter, of white, reddish and yellowish quartz, with others of a Venetian-red jasper and indurated slate, and many of white feldspar. The rock is strong and hard, and does not disintegrate rapidly in the weather, but the pebbles are very distinct on weathered surfaces. The rock is of this character on the summit, behind the residence of Mr. Alexander McLean, sen. On the summit, about three quarters of a mile west, it is composed of the same materials; but it is somewhat paler in colour, from the presence of more feldspar, and it appears to be finer grained.

* The bearings in this Report are given in relation to true north, the variation for magnetic north being 23° 15′ to the west. Practical colliers and others accustomed to use compass bearings only are particularly requested to keep this in mind, as otherwise they may be perplexed at finding the bearings in the Report so different from what they might expect. Magnetic bearings are not adopted, because these change annually, the change at present being an increase of 0° 7′ a year.

It is to be regretted that the boundary lines of the coal areas have all been run by compass instead of astronomically; the consequence is that to follow them it is necessary to know not only the original bearing of the line, but the year when the survey was made. In old surveys the difference is such that without knowing the date, which is never stated on the plans in general use, it becomes a matter of great difficulty to trace the lines on the ground, particularly through swamps and parts encumbered with brush-wood.

At the western end of McLellan's Mountain, near the residence of Mr. Robert Campbell, much of the rock is a dark gray or blackish fine grained grit, with a rough exterior and trappoid aspect; while some of it is a fine grained pistachio-green altered sandstone, with a ragged earthy fracture and gritty surface. Associated with this is a mottled green and flesh-red felsite, holding epidote, and a granular feldspathic rock, opaque white and crumbling in weathered parts, while it is much veined with white quartz. Felsites.

Beyond this, southward, the rock becomes a coarse conglomerate of a mottled red and green, in some parts reddish-black, and chocolate-red in others. Some of the inclosed masses are six inches in diameter, composed of moderately coarse grains of a reddish and white feldspar and translucent quartz, with brilliant points, which seem to be micaceous specular iron ore. Some of the pebbles weather to a brick-red and orange-vermillion, very brilliant when wet. The whole rock is cracked in all directions, in fact brecciated. The sides of the cracks and the surfaces of some of the quartz pebbles are unctuous from a coating of specular iron ore. Some of the cracks shew slickensides, and some are filled with a brown manganesian powder. Coarse red conglomerates.

Not only was this conglomerate brecciated, but so was every mass of all the series wherever met with, and to such an extent that, after hundreds of attempts, not one specimen could be dressed into an oblong shape of four by six inches, some blow of the hammer always shivering it in unexpected directions into irregular fragments, from concealed cracks. Brecciated rocks.

In the locality last named, the coarse brecciated conglomerate is followed on the south side by a south-dipping band of limestone, which has been quarried for 120 paces on the strike, near the house of Mr. Alex. Fraser. The limestone exhibits fossils, one of them being *Spirorbis carbonarius*, and belongs to the succeeding series; and there may be some doubt whether the coarse conglomerate should not be classed with it. But including this conglomerate, the older rocks have here a breadth of 650 yards, and are limited on the north by the productive coal measures, dipping northward. Limestone.

No evidence was observed by me, on McLellan's Mountain, to shew to what epoch these older rocks belong; but masses somewhat similar are noticed by Mr. Hartley on the west side of the East River, in a position where they have been mentioned in his *Acadian Geology* by Dr. J. W. Dawson, who considers them to be of Devonian age, and on his authority they will be so distinguished.

2. GREENISH-GRAY AND RED SANDSTONES WITH CONGLOMERATES AND IMPURE LIMESTONES.

This series of deposits appears to constitute a part of those which in his classification of the section examined by me at the Joggins, on

the Bay of Fundy in 1843, and published in the first of the Canadian Geological Reports in 1845, Dr. Dawson, in his *Acadian Geology*, has called the Millstone Grit, corresponding, though somewhat different in aspect, to the Bonaventure formation of Gaspé in the Province of Quebec, and to the Millstone Grit of England. On this side of the Atlantic it might appropriately be termed the Grindstone grit, as at the Joggins it yields, in large abundance, the excellent grindstones for which Nova Scotia is celebrated.

Millstone Grit.

Bonaventure formation.

Rocks at foot of Fraser's Mountain.

The largest spread of it observed by me on the east side of the East River, occupies a triangular area, of which the western apex occurs near the house of Mr. John Jack, at New Glasgow. From this, one side of the triangle runs along the south foot of Fraser's Mountain towards Merigomish Harbour, while the other has its course near the houses of Messrs. J. Mackay, Murdoch Ross, William Love and Alexander Fraser, and crossing Olden's road would reach Sutherland's River, above Ross's bridge, where the extremities of the base would be about two miles apart.

Limestone with fossils.

It was also observed on McLellan's Brook, south of the limestone mentioned as having been quarried near Mr. Alex. Fraser's. Of this band of limestone, which is shewn by its organic remains to belong to this series, the following is a descending section:

	Ft.	*in.*
Red flaggy sandstone of a free grit	2	6
Red arenaceous limestone, spotted with small masses of greenish limestone	0	6
Reddish striped nodular limestone, resembling a conglomerate of greenish limestone gravel having its interstices filled up with fine red sand	1	6
Reddish limestone of the same character, but holding more of the calcareous nodules, some of which contain *Spirorbis carbonarius*	3	2
Gray good limestone, in some parts mottled with red; it is compact in texture, and gives a conchoidal fracture. In a piece of limestone which had been quarried out of the bed, was observed a fragment of a spiral shell about half an inch broad at the base	11	0
Red arenaceous shale	1	0
	19	8

The dip of this bed is S. 2° W. <42°. As already stated it has been quarried for about 120 yards on the strike, which would be N. 88° W. On the left bank of McLellan's Brook, about half a mile from the quarry, and about ten or eleven chains north of the point where this bearing would reach a sharp elbow of the stream, there occurs an exposure of gray limestone, which, although at one part in contact with red shale or slate, does not afford the means of clearly deciding its attitude or associations. Being without fossils, it was not found possible to make out whether or not it was the same bed as the one above described or one enclosed in the older red rock. As far as I could judge, the dip appeared to be N. 22° E. <68°, and the thickness about seventeen feet.

Limestone, McLellan's Brook.

Farther up the brook, about thirty-three chains in a straight line, there occurs another calcareous band, which, with its associated strata, dips S. 1° E. < 44° – 54°. A descending section at the spot is as follows: Limestone McLellan's Brook.

	Ft.
Red sandstone of free grit, interstratified with layers of red shale	15
Red sandstone of a free grit	15
Red sandstone interstratified with thin bands of gray limestone, weathering to a straw-yellow	9
Gray limestone with interstratified yellow-weathering calcareous layers	4
Gray compact limestone with a conchoidal fracture	8
Red sandstone and red shale	45
	96

Red sandstone.

Though no fossils were observed, it is not doubted that these strata are Millstone Grit; but it is not so certain with what series to class the rocks between this calcareous band and the one farther down the stream. Of these intermediate rocks there are three exposures, with intervals of concealment. They all consist, more or less, of a brecciated red and green coarse conglomerate, similar to that north of the limestone near Mr. Alex. Fraser's. Some of the inclosed masses are a foot in diameter, and among the smaller masses was observed one consisting of reddish orthoclase feldspar, with cleavable faces of an inch in diameter. Some parts of the exposures consist of red jaspery, fine-grained, argillaceous sandstone, harder than the usual strata of the Millstone Grit series, and others appeared to be a jaspery slate. The brecciated character of all these exposures makes it extremely difficult to determine the dip; but that of a bed of slate within seven chains of the more northern band of limestone seemed to be N. 37° E. <37°. If the brecciated rocks between these limestones, and the brecciated conglomerate north of the limestone near Fraser's both belong to the Devonian series, there would appear to be a dislocation running along the valley of McLellan's Brook in this part, the conglomerates of the brook being more to the south than those near Fraser's. Brecciated red and green conglomerates.

At a bridge about a quarter of a mile above the southern band of limestone, red sandstones of a free grit, computed to be about eighty feet thick, and belonging to the Millstone Grit dip N. 61° W. <20°, and show the irregular arrangement of the strata.

In the already mentioned triangular area of this formation, which is overlooked by Fraser's Mountain, the most continuously exposed mass of strata observed was in the channel of Pine-tree Brook, between the property of Mr. James A. Fraser and Pine-tree Gut. The total thickness of this mass may be about 1,000 feet. The lower part appears to be a greenish-gray sandstone of a grindstone grit, interstratified with several bands of nodular limestone, by the people of the country, from its impurity, called *bastard limestone*, none of which appeared to be fit for burning. There Pine-tree Brook. Impure limestones.

may also be interstratified, in concealed intervals, some bands of red sandstone, but no indications of these were observed.

Greenish-gray sandstones.

As an example of this lower part, an exposure on Mr. Jas. A. Fraser's land may be taken, where, between two bands of impure nodular limestone, dipping N. 7° E. $< 34°$, the lower about eighteen inches and the upper about three feet, there is included 270 feet of greenish-gray freestone of an even grain, well suited for building purposes. The rock appears to be composed of fine grains of whitish quartz and whitish feldspar, with small disseminated grains of a black colour, the composition of which is uncertain. Some of the beds are marked by circular spots of different sizes up to a foot in diameter, which appear to be sections of sub-globular forms, containing a good deal of calcareous matter. These are of a lighter gray than the surrounding stone, and though much harder, yield more readily to the solvent power of the weather, and therefore present slight depressions, which wherever several small spots are together, give a fretted aspect to the surface. The proprietor calls them *bulls' eyes.* In the strike of the upper calcareous band a sink-hole was observed, the bottom of which, though dry, appeared to be lower than the level of the neighbouring brook.

About a third of a mile down the brook there is another exposure about ninety feet above this. It consists of the same sort of greenish-gray freestone, and with a thickness of about 130 feet is surmounted by another band of impure nodular limestone of eight inches, supported by a couple of feet of a light gray calcareous sandstone, similar in aspect to the material of the *bulls' eyes.* Farther down the brook, and about 100 feet higher in the series, there is another mass of greenish-gray freestone of about twenty feet, which has been quarried, to a small extent, for building stone. The whole of these beds, making about 600 feet, have in the distance of more than half a mile a pretty regular average dip of N. 2° E. $< 33°$, and occupy a breadth of about thirteen chains.

Pine-tree Gut.

At the junction of this brook with Pine-tree Gut, on the left side of the stream, what is called Pine-tree Bank, a wooded cliff of about fifty feet in height, presents at the base about fifteen feet of gray freestone in massive beds of from three to five feet thick. A quarry has been opened in it about seven feet above the level of the water. The quarry stone has a face of six feet, and there are eighteen inches in the middle which would yield good flagstones, while the remainder would furnish building stones of excellent quality. In the cliff above this, thick bedded red sandstones occupy twelve feet, and red shale or marl and red flaggy sandstones about twenty feet more. At the edge of the cliff, a few feet above this, there was pointed out to me by Mr. J. Weir a layer of about an inch thick, which it was supposed might be a coal seam; but observing it had beneath it a bed of sandstone, without any indication of *Stigmaria*, a

Gray and red sandstones and shales.

close examination shewed that it was only a layer of drift plants, the bark of which had yielded the coal. A band of impure nodular limestone was obscurely seen above it. The dip is here N. 33° W. <14°. Drift plants.

What is supposed to be a continuation of the gray freestone at the foot of the cliff, occurs about twenty-five chains to the eastward, on the telegraph road, at the bridge over the south branch of the brook, where a flagstone quarry, formerly worked, became covered up in the construction of the road. A bed of impure nodular limestone underlies the rock a few feet, and it appears probable that the old quarry here may occupy the same horizon as that at the summit of the series of beds already described further up Pine-tree Brook.

North of the old quarry, and eighty or a hundred feet above it, the interval being made up apparently of the red rocks of the upper part of Pine-tree Bank, and additional strata of the same character, another band of greenish-gray freestone, fit for building purposes, occurs on the land of Mr. J. Weir. It is probably between twenty and thirty feet thick, and is succeeded by red sandstones and shales, which occupy the channel of Pine-tree Brook up to the dam of Weir's mills. These red strata, about 200 feet in thickness, are succeeded on the road, close by the mill-pond, by a few feet of greenish-gray sandstone, with another band of impure nodular limestone. The whole series of strata thus described on the lower part of the brook, occupies a breadth of about twenty-eight chains, with an average dip of N. 23° W. <12°, giving a total thickness of about 400 feet. Pine-tree Brook. Weir's mills.

Proceeding westward, these upper strata gradually assume a dip eastward of north, and at the distance of about a mile in a straight line from Weir's mills, some of the red sandstones are seen on the telegraph road, dipping N. 7° E. < 31°, conforming well with the lower mass of strata in the vicinity of Mr. J. A. Fraser's, the breadth they occupy being somewhat diminished from the increase of slope. Here the upper beds come close upon the flank of Fraser's Mountain, composed of the conglomerates of the third series, towards which they dip all the way to New Glasgow. On Mr. A. McGregor's land, one of the bands of impure nodular limestone is seen at the foot of the hill, about eighteen chains north-eastward of the telegraph road, and the conglomerates of the hill crop out only a short distance north of it. A. McGregor's impure limestones.

Farther westward, much drift covers the surface, but within a mile of New Glasgow the presence of red sandstone was ascertained by Mr. J. P. Lawson in a trial-pit sunk twenty-nine feet through red clay, about thirty chains north-eastward of the old straight road running S. 63° E. from the Scotch Church. About twelve chains on the same side of this road, but more than a quarter of a mile nearer the church, greenish-gray freestone, in a shattered condition, occurs. It is overlaid by a band of impure nodular limestone, and at the junction there is a layer holding drift plants, Trial-pit on red sandstone.

chiefly *Calamites cistii.* But this exposure is on the south side of the narrowing triangular area, which comes to a point where another shattered exposure of the same freestone was met with at the foot of the rising ground on which the house of Mr. J. Jack is situated.

South side of triangular area.

On the south side of the triangle, upwards of a mile from the apex, still another shattered exposure of the greenish-gray freestone occurs, where this side of the triangle crosses the telegraph road. After an interval of about a mile and three-quarters, the next observed indication of the strata on this side is near the house of Mr. Murdoch Ross, where red sandstones are exposed with an uncertain dip. Farther on, red arenaceous strata were met with by Mr. W. Love in sinking a well near his house. Red sandstones are again seen on what is called the Pent road to the Marsh, at the foot of the hill descending from the house of Mr. Alexr. Fraser; but here also the exposure is obscure and the dip uncertain, and it is only on approaching Sutherland's River, near Ross's bridge, that the dip can be clearly made out from natural exposures, though the occurrence of red sandstones in place, is known in various trial-pits sunk on the St. Lawrence area by Mr. Haliburton.

Red rocks.

Section Ross's bridge.

At Ross's bridge the following descending section occurs, the upper part being above the bridge and the lower exposed in a cliff immediately below it:

	Feet.
Red sandstone	50
Measures concealed	90
Red and brownish-drab sandstone	60
Brownish-red sandstone	60
Red and greenish-yellow mottled sandstone	180
Greenish conglomerate, with pebbles of a whitish quartzite and greenish argillaceous sandstone, spangled with small flakes of mica ; all the pebbles are green externally. This layer is of varying thickness, from three inches to	1
Red shale	7
Red sandstone	2
Green shale	2
Green crumbling sandstone in thin bands, separated by green shale or more crumbling sandstone	4
Red sandstone and red shale	16
Yellowish sandstone mottled with green and red	14
Red and green mottled sandstone	4
Greenish sandstone mottled with red	9
Red sandstone	9
Red shale	5
Red sandstone	6
	519

These strata occupy a breadth of nearly a quarter of a mile, with a dip which, upon an average, is S. 23° E. $<$ 24°, and the same attitude may

extend some distance farther down Sutherland's River. The dip is the reverse of that at Weir's mills, and between these places there must thus be at least one anticlinal form, and possibly more; but whether any rocks lower than the Carboniferous are brought to the surface in the interval has yet to be ascertained. Anticlinal,

3. RED COARSE CONGLOMERATES.

New Glasgow conglomerates.

At the bridge of New Glasgow is exposed a series of conglomerates, which, in general colour, are between a brick-red and chocolate or Indian-red, and whose inclosed masses, varying from the smallest pebbles to boulders of two feet in diameter, are, for the most part, unmistakably derived from the red and greenish-gray sandstones, red shales and impure nodular limestones of the rock last described, some of them containing the same vegetable organic remains. With these pebbles and boulders are associated a few from the rocks still lower down. The whole are inclosed in a matrix of the same mineral character, constituting an argillo-arenaceous cement, which is also calcareous, and in the interstices of the boulders and pebbles is often observed a network of white calc-spar aiding to keep them together. There are interstratified in the rock, bands, from a few inches to several feet in thickness, of fine red sandstone and red shale, which serve to give assurance of the dip, and these occur at such distances apart as to render the conglomerate beds thick and massive, their transverse measure varying from ten to some times nearly 100 feet.

To this rock Dr. Dawson has given the name of the New Glasgow conglomerate. From a point a short distance above the bridge, to one much farther below, these conglomerates have a breadth of very nearly a mile, with a dip, which on the average is N. 3° —13° W., with a slope gradually diminishing from 50° in the lower to about 30° in the upper part, and giving a total thickness of about 1,600 feet. As already indicated, this great mass of conglomerate composes Fraser's Mountain, towards the south flank of which, presenting the outcrop escarpment of the inferior part, the red and gray strata of the Millstone Grit dip in such a way as, without other evidence, to induce the supposition that the one series overlies the other conformably. But on the west side of the East River Mr. Hartley has evidence to show that there is a want of conformity, at least in some places. Thickness.

Moose Fraser's Concretionary limestone,

Three miles eastward of New Glasgow these conglomerates have a breadth, between their base, east of the house of Mr. A. McGregor, and their summit, on a property formerly belonging to Mr. William Fraser (Moose) of about fifty-four chains, and they are here immediately and conformably overlaid by the following ascending section:

Section.

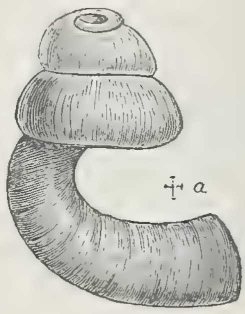
Concretionary beds.

	Ft.	in
Gray limestone which has been quarried for burning	20	0
Measures concealed	10	0
Bluish-gray slightly calcareous sandstone		5
Bluish-brown concretionary limestone, the surface of which presents concentric botryoidal thinly laminated concretions, with grayish and red clay in the interstices and inequalities		10
Gray and red clay		8
Reddish concretionary limestone, with concentric botryoidal laminæ as before	1	0
Whitish-gray limestone	1	0
Gray and red mottled clay, resembling fireclay	1	4
Gray flaggy sandstone	1	8
Gray clay		6
Whitish arenaceous limestone, holding abundance of *Spirorbis arietina* *	2	2
Grayish-blue, spotted, slightly argillaceous sandstone	1	0
Measures concealed, including several feet of underclay	24	0
Coal and black carbonaceous shale, including about eighteen inches of good coal at the bottom, which used to be mined by Mr. W. Fraser, for the purpose of burning the limestone in the lower part of the section	4	5
	69	0

J. Small's Concretionary limestone.

The dip of these strata is N. 10° W. <47°, and very nearly on the strike this would give, they are again met with on a brook on the property of Mr. James Small, on the road to Little Harbour, Merigomish. The one locality is as much as three miles from the other; but the botryoidal concretionary limestone layers in both are so peculiar and so strikingly like in appearance, and in their relation to an overlying seam of coal, that no doubt can be entertained of their equivalence. At Mr. Small's the dip

* This is a new species, obtained by Mr. Hartley, who, with Dr. Dawson and myself, visited the locality in August, 1868, and the following is a description of it, kindly supplied by Dr. Dawson. The figure is magnified thirteen diameters, the natural size being shewn at *a*.



Spirorbis arietina.

Dawson's description of *Spirorbis arietina.*

Spiral; sinistral; whorls four, the first three regularly spiral, and somewhat close, the last becoming irregular; cross section circular; shell thin, with delicate tubular structure, much finer than in *S. carbonarius;* surface uneven, with obscure wrinkles on the last whorl, and microscopic lines of growth on earlier whorls; apex flattened for attachment on first whorl only; length 1-10 to 1-8 inch (about 3 millimetres.)

of this limestone is about N. 23° W. <9°. The underlying conglomerate was not exposed; but there is no reasonable doubt of its occurrence beneath, and I have no evidence yet to shew that the mass is here of less volume than farther to the west.

The calcareous band with which these concretionary limestones are associated was not observed above the conglomerates on the East River, but immediately north of the position where they terminate, on the east side of the stream, after a concealed interval of 200 paces, they are succeeded by whitish sandstones, dipping north at an angle of 16°, which, a little way on, is reduced to 8°, and this low rate of inclination is maintained by the measures for a considerable distance toward Pictou, with an occasional flat undulation, reversing the dip. The apparent place of the limestone would be in the concealed interval in question. **Place of concretionary limestones on the East River.**

4. PRODUCTIVE COAL MEASURES.

In the district which has engaged my special attention, the thick covering of drift so extensively concealing the strata, the dislocations which are known to affect these in some places, and the facts which suggest the probability of disturbances in others, while little has yet been revealed by crop workings, will make it difficult, for some time to come, to build up a column shewing a perfect series of the measures; and what is now offered is to be considered as only a distant approximation to the truth, to be improved hereafter as occasion may serve, and farther developments may occur. **Productive coal measures.**

The most continuous exposure of the strata observed lies in the channel of McLellan's Brook, in which the rocks are bared, with short intervals of concealment, from nearly its mouth to the gap between McLellan's and McGregor's Mountains, and much farther beyond. But this section does not reach the highest strata, and some of the measures are repeated by an undulation. A portion of the beds, however, is seen nowhere else. **McLellan's Brook section.**

The highest coal seam with which I have been able to connect the section, appears to me to be one of which the crop was ascertained by Messrs. McBean, on the dividing line between the first and second square mile of their three-mile area, going south-eastward, and about 250 paces from the stake at the south-western end of the line. Here there are five

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The specimens described were found by Mr. E. Hartley, in limestone belonging to the coal formation, and immediately overlying the New Glasgow conglomerate. The occurrence of *Spirorbis* in this bed is mentioned in *Acadian Geology*, p. 326, but it is not distinguished from the ordinary S. *carbonarius*, from which, however, Mr. Hartley's specimens shew it to be very distinct. It is so regularly spiral that it might be mistaken for a gasteropod shell; but its apex, flattened for attachment, and its microscopic structure, show it to be a worm shell. It was probably, like S. *carbonarius*, attached to submerged plants; but in the limestone above mentioned, it occurs loose in great numbers, having probably been drifted from its attachment. J. W. D.

small trial-pits and bore-holes in a distance of about eleven chains on the strike. In one of these, according to Mr. A. McBean, seven feet of coal were pierced under five feet of gravel, and in another five feet of coal under three feet of gravel, while the crop was touched in the others. The average strike of the crop is about N. 67° E., and the dip southward, but I am not able to state the rate of slope.

Six-feet coal seam.

A little to the west of north from this, at a distance of about twenty-two chains, reduced to a straight line, directly across the strata, Messrs. McBean sunk a trial-pit and bore hole on the south side of St. Mary's road, not far from the house of Mr. J. McDonald (turner), penetrating, at the depth of twenty-feet, through four and a-half feet of coal. This they consider to be the same seam as that to which they sunk a pit about eighteen chains to the eastward of north from it, where it was four feet four inches in thickness, and identical with the seam which they worked by a slope about sixteen chains farther on the crop to the north-westward. This seam was previously worked by a slope about thirty-five chains still farther to the north-westward, by Mr. George McKay, for which reason it goes by the name of the George McKay four-feet seam. To the deep of McKay's slope, the Pictou Mining Company have sunk a shaft to this seam, at the Marsh Colliery, completed in October, 1868, and we thus have a section of part of the ground between McBean's six-feet and four-feet seams.

George McKay four-feet seam.

The inclination of the strata at McKay's slope is about 1 in 4, the dip at the mouth of the slope being N. 34° E., $<16°$; but the measures appear to spread considerably, going round by the crop to St. Mary's road, and it is probable that the rate of dip there is not more than 1 in 4½. This would give about 310 feet between McBean's six-feet and four-feet seams, and place the six-feet seam about ninety feet above the measures intersected in the Marsh pit. Combining these with what can be gathered from the Marsh Brook and McLellan's Brook, the following would be the series, as near as I can make it out from measurements by pacing, made by myself in 1868, and remeasurements by chain by Mr. Hartley in 1869.

Marsh pit.

For the convenience of comparison this whole series of deposits is divided into three parts or horizons—A, B, and C, and Sections under these are given in sequent numbers.

Divisions and sections.

Division A, including Section 1.

Division B, including Sections 2, 4, 5, 6, 8.

Division C, including Sections 3, 7, 9.

SECTION 1. (DIVISION A.)

MEASURES INTERSECTED IN THE MARSH COLLIERY PIT.

Measures Marsh pit.

	Ft.	In.	Ft.	In.	
Dark gray argillaceous shale	3	0			
Gray impure fireclay	49	0			
			52	0	
Coal.—The Captain seam			3	0	Captain seam.
Gray fireclay	4	10			
Gray arenaceous shale	3	0			
Gray solid sandstone	4	6			
Gray argillaceous shale	8	9			
			21	1	
Coal.—A seam of inferior quality			1	8	
Gray fireclay	4	0			
Gray arenaceous shale	6	10			
			10	10	
Coal			0	3	
Gray fireclay	3	5			
Gray arenaceous shale	7	10			
Gray fireclay	2	0			
Gray strong solid sandstone	24	4			
Gray sandstone	18	6			
Gray arenaceous shale	8	4			
			64	5	
Coal.—The Mill-race seam.					Mill-race seam.
Cannel coal	0	9			
Mineral charcoal mixed with coal	0	3			
Good coal	2	1			
			3	1	
Gray soft fireclay, without divisions, holding occasional nodules of clay ironstone	17	6			
Gray flaggy sandstone, with thin black partings arranged in wavy layers	8	9			
Gray hard sandstone in one bed	6	0			
Gray shaly sandstone, with interstratified bands of gray hard sandstone of from one to four inches thick	19	6			
Dark gray argillaceous shale, with a few nodules of clay ironstone	11	9			
			63	6	
Coal—The George McKay seam.					George McKay seam.
Coarse shaly coal	0	3			
Good coal	3	6			
			3	9	
			223	7	

SECTION 2. (DIVISION B.)

MEASURES ON MARSH BROOK, FROM THE GEORGE MCKAY FOUR-FEET SEAM TO MCLELLAN'S BROOK.

Measures Marsh Brook.

	Ft.	In.	Ft.	In.
Gray fireclay, with great abundance of *Stigmaria*	3	0		
Measures not well ascertained, but supposed to consist chiefly of arenaceous shale and flaggy sandstone, with some black carbonaceous shale at the top	190	0		
			193	0

		Ft.	In.	Ft.	In.
Ten-inch seam.	*Coal.—The ten-inch seam.* A trial-pit has been sunk on the crop on the Marsh Brook				10
	Fireclay	2	6		
	Black carbonaceous shale, chiefly	90	0		
				92	0
Oil shale.	*Oil shale.*—A seam worked to a small extent in a trial-pit on Marsh Brook, sunk by Mr. Haliburton; the thickness is uncertain.			4	0
	Measures concealed	42	0		
	Black carbonaceous shale	5	0		
	Measures concealed	69	6		
	Light gray arenaceo-argillaceous shale	6	0		
	Black argillaceous shale not well exposed, there being many small intervals of concealment	72	0		
	Measures concealed	31	0		
	Dark bluish-gray argillaceous shale, not well exposed	20	0		
	Measures concealed	12	0		
	Black carbonaceous shale	16	9		
	Measures concealed	36	0		
	Black carbonaceous shale	10	0		
	Measures concealed	14	9		
	Black argillaceous shale	10	3		
	Measures concealed	26	8		
	Black carbonaceous shale	9	9		
	Measures concealed	2	9		
				384	
Small coal seam.	*Coal,* Cannel				
	Gray fireclay	3	0		
	Light and dark gray fine grained flaggy sandstone	6	8		
	Yellowish-drab thick bedded sandstone, weathering rusty	8	0		
	Measures concealed	5	9		
	Yellowish-drab thick bedded rusty-weathering sandstone	4	8		
	Bluish-gray flaggy sandstone, with occasional carbonaceous partings	5	0		
	Measures concealed	38	0		
	Bluish-gray flaggy sandstone	1	0		
	Measures concealed	30	6		
	Yellowish-drab sandstone, in thin layers with false bedding, some parts weathering brownish-red	3	0		
	Measures concealed	4	5		
	Dark bluish-gray, brown-weathering sandstone, in some parts rust-brown	3	0		
	Dove-gray slightly arenaceous fireclay, weathering greenish-gray, and very soft when weathered	1	3		
				114	
Supposed coal seam.	*Coal.*— A seam supposed probable here			0	
	Measures concealed	7	5		
	Bluish-gray fireclay banded with dark gray, in layers from one-fiftieth to one-twentieth of an inch thick, the whole weathering dark brown or almost black	1	6		
	Measures concealed	13	0		
	Light bluish-gray argillaceous shale	0	6		
	Measures concealed	8	0		
				30	
				819	

SECTION 3. (DIVISION C.)

MEASURES ON McLELLAN'S BROOK FROM THE MOUTH OF MARSH BROOK TO BLACK'S MILL-SITE.

Measures McLellan's Brook.

	Ft.	In.	Ft.	In.	
Gray arenaceous shales and sandstones, some beds weathering purplish-brown or reddish	25	0			
Black carbonaceous shale	8	0			
Measures concealed	35	0			
Gray flaggy sandstone	3	8			
Measures concealed	79	0			
Very dark bluish-gray sandstone, extremely hard and fine grained and weathering brown	1	0			
Measures concealed, but there appears to be sandstone in the bed of the stream	32	0			
Black carbonaceous shale	28	0			
			211	8	
Coal.—A seam of hard coal but of fair quality				7	Small coalseam.
Very light gray fireclay, full of carbonized *Stigmaria*	2	6			
Gray argillaceo-arenaceous shales and flaggy sandstones, passing into each other	16	0			
Whitish-gray very compact heavy bedded freestone	3	4			
Light and dark gray argillaceous shales	4	6			
Black coaly carbonaceous shale	2	0			
			28	4	
Coal.—The Widow Chisholm seam,—of fair quality but hard			1	0	Widow Chisholm seam.
Yellowish-drab argillo-arenaceous very fine grained underclay with *Stigmaria*	2	3			
Dark gray compact sandstone, weathering rust-brown, full of *Stigmaria*	2	0			
Dark gray compact sandstone, weathering rust-brown, with occasional clay ironstone balls	3	7			
Dark yellowish-drab and brownish-drab sandstone, weathering rust-brown, in rather coarse thick beds	5	5			
Dark yellowish-drab and brownish-drab flaggy sandstones with very micaceous partings between some of the beds	25	0			
Measures concealed	14	6			
Dark yellowish-drab and brownish-drab flaggy sandstones shewing large casts of *Calamites cistii*, some of them four inches in width	2	0			
Measures concealed	2	3			
Dark yellowish-drab sandstones	9	6			
Dark yellowish-drab sandstones only partially exposed	49	0			
Dark yellowish-drab sandstones with false bedding and ripple-mark, and having black micaceous partings more conspicuous towards the base	61	0			
Black semi-carbonaceous shale, with occasional clay ironstone balls	20	0			
Black highly carbonaceous shale, compact, with two sets of cleavage planes, dividing it into cuboidal blocks about one foot in diameter	5	0			
Purplish-gray fine grained sandstone	6	6			
Measures concealed	9	9			
Black carbonaceous shale	3	9			

		Ft.	In.	Ft.	In.
	Measures concealed	15	0		
	Black carbonaceous compact shale	8	3		
	Measures concealed	8	6		
	Yellowish-drab heavy bedded sandstone, weathering light drab...	11	4		
	Measures concealed	8	10		
	Yellowish-drab sandstone	9	6		
	Measures concealed	16	6		
	Yellowish-drab sandstone, generally flaggy, with wavy dark micaceous partings	34	6		
	Brown arenaceous shale, weathering gray	5	6		
	Gray argillaceous shale	1	6		
	Black carbonaceous shale, very compact	4	6		
	Light gray arenaceous shales and sandstones, with a few inches of gray argillaceous shale at the base, containing a band of clay ironstone two inches and a-half thick	15	9		
	Ash-gray sandstone, very heavily bedded, one of the beds thirty-three inches thick, without any partings	12	2		
	Grayish-drab coarse sandstones, with rust-stained partings	8	3		
	Measures concealed	24	6		
	Yellowish-drab sandstones, in thick beds, with wavy partings and much false bedding	10	0		
	Yellowish-drab flaggy sandstones	6	6		
	Gray rusty-weathering sandstone	0	8		
	Bluish-gray argillaceous shale	2	6		
	Yellowish-drab sandstone	49	6		
	Measures concealed	26	3		
	Yellowish-drab sandstone	2	0		
	Measures concealed	3	2		
	Yellowish-drab sandstone	9	0		
	Measures concealed	3	2		
	Black highly carbonaceous shale, very compact and not easily broken	29	0		
				547	1
Small coal seam.	*Coal*			0	
	Yellowish-drab underclay, full of *Stigmaria*, and holding occasional disseminated clay ironstone balls from one-eighth to one-fourth of an inch in diameter	2	9		
	Measures concealed	2	0		
	Light gray compact rusty-weathering sandstone	0	6		
	Light gray arenaceous shale, weathering of a greenish tinge, in coarse beds with dark partings	1	6		
	Light gray fine grained arenaceous shale with dark partings	2	9		
	Light yellowish-drab sandstone	2	6		
	Measures concealed	17	6		
	Very light yellowish-drab sandstone, weathering red, with much false bedding	10	8		
	Measures concealed	3	6		
	Very light yellowish-drab sandstone with much false bedding	1	0		
Upright *Sigillaria.*	Gray sandstone, weathering drab. At the bottom of this there is a fragment of an upright *Sigillaria;* it is a sandstone core of about seven inches long, with a diameter of four inches and a-half; it is constricted towards the bottom, and then spreads out a little on a thin layer of shale beneath. No				

	Ft.	In.	Ft.	In.
roots were observed beneath, and the shale on which it is based passes just over the top of another upright *Sigillaria*, a few feet removed on one side	4	0		
Gray sandstone with three inches of shale on top	1	0		
Gray sandstone, weathering drab; the lower and upper parts of the bed are somewhat shaly, with two inches of soft clay on top	2	3		
Dark gray argillaceous shale, with nodules of clay ironstone. In this bed, in the distance of twenty-five feet, there are the remains of three upright *Sigillariæ*. The largest of them is about eighteen inches in diameter; a length of forty-three inches of it remains. Towards the lower part it becomes constricted and then spreads out to a wider diameter on the bed beneath. It is a sandstone cast of the plant. The remains of the other two occur at the top of the bed, in the form of sandstone cores, each of them about seven inches long, one of them being five inches and the other seven inches in diameter; the former penetrates eleven inches into the layer of sandstone above, and the hollow semi-cylindrical mould of the other is visible in the upper bed for forty-five inches, from which the plant has been removed, while at the length of twenty-four inches in the sandstone the form is cut by two inches of soft shale. All the three plants probably had roots in the same bed of shale beneath, and these may have penetrated to a bed of sandstone still lower, which is marked by the presence of *Stigmaria*, but no connection could be found between these roots and the upright plants	4	0		
Gray argillaceous shale	1	0		
Gray soft argillaceous shale or clay	0	3		
Gray flaggy sandstones in irregular layers, with remains of prostrate plants	1	6		
Gray sandstone in a single bed, marked by the presence of *Stigmaria*	3	0		
Gray flaggy sandstones, weathering drab, with wavy surfaces, interstratified with argillaceous and arenaceous shales	7	0		
Gray arenaceous shale and thin sandstones interstratified with beds of dark gray argillaceous shale	4	0		
Gray arenaceous shale, with beds of sandstone weathering to a mottled red and drab	6	0		
Measures concealed, probably flaggy sandstones	28	0		
Gray flaggy sandstone, weathering drab, with ripple-mark	16	0		
Gray argillaceous shale, with layers of gray flaggy sandstone, which are wavy and weather to a mottled drab and red	5	0		
Gray flaggy sandstone interstratified with gray arenaceous shale	7	0		
			134	8
			924	4

Three upright *Sigillariæ*.

This section terminates near the old mill-site belonging to Messrs. S. Black and A. Walker, where the measures appear to be interrupted by a fault. Evidences of a disturbance are plainly visible in the cliff overlooking the stream on the right bank; but I was unable to make out

Black's mill-site.

clearly, from the cliff, which way the measures are thrown. In McLellan's Brook, all the way up to the mouth of Marsh Brook, the strata of Division C dip to the south-eastward. On the main stream, above the junction of the tributary, the same dip is maintained in the prolongation of the Marsh Brook series (Division B) to within twenty-six chains of the Fulling-mill bridge, the slope of the strata, all the way from Black's mill-site, varying from 8° to 20°. The measures are largely composed of sandstones, the strike of which is, of course, south-westward. From Black's mill-site downwards to the junction of McLellan's Brook with the East River, the measures are apparently all black shales, the chief part of them carbonaceous, giving a great thickness, with no sandstones observed. The dip of these shales is more or less north-eastward, at angles ranging from 8° to 24°. Their strike would be south-eastward, and in the prolongation of the strata in this direction, they would apparently come against the sandstones irregularly. The continuous contact of these two masses is concealed, but a line running about S.S.E. from Black's mill-site, crossing the old mill road a little north of the house of Mr. J. W. Turnbull, and coming on McLellan's Brook in the gap between McLellan's and McGregor's Mountains, would apparently have the sandstones on the east, while the black shales would be on the west, and it is probable that a dislocation, which may be called the Mill-road fault, more or less coincides with this line all the way. As no mass of arenaceous measures presenting the same characteristics as those of McLellan's Brook, is known below the black shales, the sandstones are supposed to be the higher in the series, and the dislocation would thus seem to be a downthrow to the eastward; but what may be the extent of the break, the evidence is not at present sufficient to decide.

S. E. dip.

Black shales McLellan's Brook.

N. E. dip.

Mill-road fault.

As already stated, the south-eastward dip of the arenaceous measures on McLellan's Brook is maintained to within twenty-six chains of the Fulling-mill bridge. At this point, a seam of oil shale, formerly worked by Mr. Patrick, comes upon the brook. It is supposed to be on the same horizon as the oil shale on Marsh Brook, and the strata associated with it being more exposed on the main stream than on the tributary, we obtain additional details.

Oil shale.

Patrick's working.

The measures here lie in the form of a synclinal, on the opposite sides of which, at the right margin of the stream, the two out-crops of the oil shale are about 200 paces apart. A fault runs in the brook in a bearing of N. 36° W. It appears to be a downthrow on the north-west side producing on that side a greater separation of the out-crops. On the northern out-crop the evidences of the dislocation are in the middle of the stream, where black shales, on the south-east, come against sandstones on the north-west. Between the two there runs a thin vein of quartz, the underlie of which is N. 54° E. $<$ 38°, and fragments of the quartz obtained from the vein, shewed well marked slickensides next the sandstone.

Synclinal.

Fault.

Patrick's slope on oil shale.

On the south out-crop, and on the north-west side of the fault, there are the remains of an old slope sunk by Mr. Patrick. The dip at the mouth of the slope is N. 22° E. $<29°$; and I was informed by Mr. A. McBean that in descending this slope the oil shale maintained a thickness of from two to six inches for about twenty feet; it then gradually thickened to five feet in descending sixty feet farther, while the dip gradually became N. 67° E. $<52°$; descending eight feet more, the deposit diminished to nothing; and in eight feet still further, the face of the fault presented itself, the strata becoming vertical. In the thickest part of the oil shale, a horizontal gallery was driven twenty yards to the left, and in this distance the seam thinned from five feet to fifteen inches, then again thickened and again thinned.

Variation of thickness.

Felt-like structure of oil shale.

From the description of Mr. McBean, and from the specimens shown me, the best and most typical parts of the oil shale appear to have a curly or felt-like structure. It is this part which varies so much in thickness, and while the bottom of the deposit remains even, the thinning arises from depressions in the upper portion, which are filled up with even layers of the more ordinary carbonaceous shale. The out-crops approach one another to the north-west, and the turn on the axis of the synclinal occurs about 300 yards from the margin of the brook. The measures associated with the oil shale on the opposite out-crops, as exposed on the brook, are as follows, in descending order, both sections belonging, of course, to the Division B:

Axis of synclinal.

SECTION 4. (DIVISION B.)

MEASURES ON THE SOUTH OUT-CROP FROM THE HIGHEST BEDS SEEN ABOVE THE OIL SHALE UP McLELLAN'S BROOK TO THE FULLING-MILL BRIDGE.

Measures on south out-crop.

	Ft.	*In.*	*Ft.*	*In.*	
Brownish-gray fine grained sandstone, weathering brown	0	9			
Measures concealed	4	7			
Gray compact sandstone, with wavy micaceous partings	0	10			
Measures concealed	2	0			
Dark gray flaggy sandstone, weathering brownish-gray	1	0			
Measures concealed	5	3			
Bluish-gray argillaceous shale	2	3			
Measures concealed	2	0			
Bluish-gray argillaceous shale	1	6			
Black highly carbonaceous shale	13	6			
Measures concealed	13	8			
			47	4	
Oil shale.—A seam varying in thickness from one inch to eight feet			4	0	Oil shale.
Measures concealed	26	0			
Black argillaceous shale	8	10			
Black carbonaceous shale	3	5			
Measures concealed	164	0			
			202	3	

Margin	Description	Ft.	In.	Ft.	In.
Coal seam.	*Coal.*—A seam on which a pit has been sunk about 125 paces on the strike (S. 64° E.) from the margin of the brook.				
	Cannel coal	0	3		
	Bituminous coal	1	6		
				1	9
	Grayish-drab fine grained arenaceous underclay with *Stigmaria*.	3	0		
	Gray sandstone with wavy partings, and holding occasional clay-ironstone balls	2	4		
	Measures concealed	7	4		
	Dark gray arenaceous fireclay	7	0		
	Measures concealed	8	0		
	Light gray rusty-weathering sandstone, in thick beds	6	0		
	Measures concealed	2	3		
	Light gray soft-weathering arenaceous fireclay	1	8		
	Gray rusty-weathering sandstone	1	3		
	Measures concealed	2	0		
	Black semi-carbonaceous fireclay, slightly arenaceous, with a whitish-brown streak	5	0		
	Measures concealed	12	6		
				58	4
Coal seam reported.	*Coal.*—A seam reported to be here			1	0
	Very dark gray fine grained fireclay, weathering very soft, with *Stigmaria*	1	10		
	Light gray arenaceous underclay, with dark partings, holding *Stigmaria* and casts of *Calamites cistii*	1	6		
	Light gray sandstone, with occasional clay ironstone balls	4	3		
	Dark gray shaly sandstone	2	0		
	Dark gray sandstone in thick beds	12	0		
	Measures concealed, with one or two small exposures of dark semi-carbonaceous indurated shale	43	0		
	Dark gray, rusty-weathering sandstone, not well exposed	24	0		
	Measures concealed	9	0		
	Dark gray rusty-weathering sandstone				
	Measures concealed, but probably sandstone of the same character	25	0		
				122	7
				437	3

SECTION 5. (DIVISION B.)

Measures on north out-crop.

MEASURES ON THE NORTH OUT-CROP FROM THE HIGHEST STRATA SEEN ABOVE THE OIL SHALE, DOWN McLELLAN'S BROOK.

Description	Ft.	In.	Ft.	In.
Brownish-gray fine grained sandstone in one bed, weathering brown	1	3		
Measures concealed	0	6		
Light gray compact sandstone	2	6		
Measures concealed	0	6		
Light gray flaggy sandstone	5	0		
Dark bluish-gray argillaceous shale	1	6		
Dark brownish-gray sandstone	4	6		
Measures concealed	22	0		
Black semi-carbonaceous shale	15	0		
			52	9

	Ft.	In.	Ft.	In.	
Oil shale.—A seam of black highly carbonaceous shale, containing lenticular masses of a substance like oil shale, as proved in a pit sunk to by the Pictou Mining Company..........			0	4	Oil shale.
Black carbonaceous shale....................................	2	0			
Measures concealed..	15	4			
Light bluish-gray argillaceous shale........................	1	6			
Black carbonaceous shale....................................	9	0			
Measures concealed..	46	0			
Black carbonaceous shale....................................	5	0			
Measures concealed..	17	6			
Black semi-carbonaceous shale...............................	5	0			
Black argillaceous shale....................................	6	8			
Black carbonaceous shale....................................	5	0			
Black carbonaceous shale, very compact and tough.............	5	3			
Measures concealed..	13	6			
Brownish-drab thick bedded sandstone, weathering rusty, with black micaceous partings............................	4	5			
Gray very fine grained sandstone, with clay ironstone balls.....	4	9			
Gray very fine grained sandstone, partially concealed..........	6	6			
Very light gray fine grained sandstone, weathering rusty in the partings..	1	4			
Gray sandstone, with black partings..........................	27	6			
Brownish-drab flaggy sandstone, weathering brown............	3	9			
Blackish-gray argillo-arenaceous shale, interstratified with light-gray arenaceous shale, with black partings..............	6	6			
Dark brownish-drab fine grained sandstone, weathering rusty...	4	9			
Dark bluish-gray arenaceous fireclay, weathering very soft in some beds..	6	11			
			198	2	
Coal.—A seam supposed probable in this place.................			0	0	Supposed coal seam.
Dark bluish-gray arenaceous fireclay, partially concealed......	7	5			
Measures concealed..	20	0			
Gray sandstone, with black wavy micaceous partings..........	24	10			
Measures concealed..	7	9			
			60	0	
Coal.—A seam supposed to be about this horizon..............			0	0	Supposed coal seam.
Measures concealed..	80	0			
Black carbonaceous shale....................................	9	7			
			89	7	
			400	10	

Both of these sections terminate at dislocations. That concluding at the Fulling-mill bridge comes against a break of considerable importance ; its course appears to be N. 77° E., and it may be called the Fulling-mill fault. *Fulling-mill fault.*

The whole area of Productive coal measures belonging to that part of the Pictou field which has been under the examination of Mr. Hartley and myself, is included between two great upthrow dislocations, which may be termed the North and South faults. The former crosses the East River a little above New Glasgow bridge, where it brings the productive measures abruptly against the New Glasgow conglomerates. It thence runs to *Great North fault.*

Sutherland's River along the south side of the triangular area of Millstone Grit rocks which has been previously described, the bearing being about S. 82° E. for one-half of the distance, and S. 68° E. for the other. The South fault crosses the East River about three and a-half miles further up, skirts the north side of McGregor's Mountain, and intersecting McLellan's Brook about seventeen chains above the Fulling-mill bridge, passes along the north foot of McLellan's Mountain and strikes Sutherland's River about fifty chains below McPherson's bridge. This fault has on the south side the Devonian rocks of McGregor's and McLellan's Mountains, bringing those of the former mountain to abut against the great mass of black shales* lying west of the Mill-road fault, and those of McLellan's Mountain against the higher and more arenaceous deposits of the divisions A, B, and C.

Great South fault.

Black shales.

Immediately east of the Mill-road fault these more arenaceous deposits appear to occupy the whole space between the North and South faults, in which space they are arranged in three synclinal forms, the axes of two of which, bearing eastward, are a little more than a mile and a-half apart; one of them, already alluded to, running in the vicinity of Patrick's old workings on the oil shale, and the other a little north of the pit sunk at the Marsh colliery to the George McKay four-feet coal seam. There is however a third parallel synclinal axis, over half a mile north of the latter, which passes along the upper part of Potter's Brook near the telegraph road, and comes obliquely against the North fault. These synclinals may be called the South, Middle (or Marsh), and North, the Middle one being the most important.

Arenaceous measures.

Three synclinals.

South, Middle and North.

The out-crop of the George McKay seam on the south rise of the Middle synclinal is seen in the George McKay slope, and its course from this, as marked by the Pictou Mining Company's trial-pit, (thirty-six feet to the coal), and McBean's slope on the crop, is about S. 62° E. But farther on, as already indicated, it takes a more southward course, and folding over the axis of the anticlinal, which lies between the Middle and South synclinals mentioned, it reaches the St. Mary's road about 200 paces south-eastward of the house of Mr. Jas. McDonald, (turner), in McBean's trial-pit and bore-hole. It has not been tested by continuous trial-pits farther on, but between fifty and sixty chains to the south-west, in what appears to be the general strike of the measures, a trial-slope, about 230 paces outside of Messrs. McBean's south-western boundary, has been sunk on a coal seam on the left bank of a small stream running north-westward near the house of Mr. McGregor.

George McKay coal seam.

McBean's trial-pit.

Trial-slope near McGregor's.

According to Mr. A. McBean, the thickness of this seam is three feet six

* It is supposed to be possible that a triangular area of Millstone Grit rocks may be interposed for part of the way between the South fault and one branching from it, and that towards the East River the black shales may abut against such rocks.

nches, and the dip at the mouth of the slope, which is about four feet above the stream, is S.16°E.$<$19; but at nine feet down the slope the roof suddenly assumed an inclination of 70°. In another slope sunk at the level of the brook and a few paces to the north-east, the sudden increase of inclination occurred at a depth of about four feet; and by this it would appear that a fault is here present running about east and west, which would account for the irregularity of the strike at the mouths of the slopes. This seam is supposed to represent the George McKay four-feet seam. The dislocation may be called the McGregor fault. McGregor fault.

On the right bank of the same brook, about a quarter of a mile further up, and a little within the south-western boundary of the McBean area, three small trial-pits have been sunk on a coal seam about four hundred paces from the south-west corner of the line between the first and second square miles. The thickness and character of the coal, I am not able to state with exactness, but the former appears to be from three to four feet, and the coal is covered by at least eight feet of black shale. The dip at the crop is S. 43° E. $< 17\frac{1}{2}$° ; but according to Mr. McBean the inclination, after descending a short distance, suddenly increases to a considerable angle, and a crack in the coal at the bend is filled with shale similar to that of the roof. If the dip of the measures to the north-west be the same as that at the crop, this seam would appear to be about 160 feet over the George McKay seam, which is about the horizon of the Captain seam in the Marsh pit. Coal seam supposed equivalent to the Captain seam

Several trial-pits and slopes have been sunk upon the south out-crop of the Captain and Mill-race seams in the vicinity of the Marsh pit, establishing the run of these seams, and shewing apparently a small divergence from the George McKay seam, going eastward, probably from some diminution of the inclination. Proceeding in an opposite direction from the George McKay slope, trial-pits which have been sunk on the crop of this seam, as pointed out to me by Mr. Lawther, exhibit the turn of the seam upon the axis of the synclinal about thirty chains westward from the Marsh pit, and the run of the Marsh pit group of seams on the north rise is indicated first by a slope sunk by Mr. Lawson on the Captain seam, for the Merigomish Company, near the north-west boundary of their area, about twenty-two chains from the south-west corner post. Captain and Mill-race seams. Axis of Middle synclinal.

The coal is here three feet thick, and the dip at the mouth of the slope is S. 20° E. $< 17\frac{1}{2}$°. This inclination continues for eighty feet down the slope, when a downthrow occurs about equal to the thickness of the coal, beyond which the inclination becomes 22°, and continues so for forty feet. In a bearing N. 67° E. from this, at a distance of about 850 paces, Mr. Lawson, by direction of Mr. Moore, has tested the whole of the Marsh pit group of seams, on a small stream which flows down the south slope of the Captain seam, Merigomish area. Marsh pit group tested by Lawson.

McPherson's Brook.

hill from Donald McPherson's land. Here Messrs. McBean had sunk a small slope on the Captain seam, at a spot about six chains from the north-west and about twenty-four chains from the north-east boundary lines of their area.

According to Mr. A. McBean the thickness of the seam is here four feet, and the average dip of the measures is S. 28° E. < 45°. Agreeably to the measurements of Mr. Lawson, reduced to vertical thickness at right angles to the plane of the beds, the following is a descending section of the seams, with their distances apart:

				Ft.	*In.*
Captain seam.	*Coal.—The Captain seam*			4	0
	Intermediate measures			21	0
	Coal			0	10
	Intermediate measures			85	10
Mill-race seam.	*Coal.—The Mill-race seam.*				
	Good coal, half of it being cannel	0	6		
	Clay	0	8		
	Good coal	1	0		
	Shaly coal	1	10		
				4	0
	Intermediate measures			52	2
George McKay seam.	*Coal.—The George McKay seam.*				
	Shaly coal	0	10		
	Good coal	3	6		
	Shaly coal	0	3		
	Good coal	0	3		
				4	10
				172	8

Increase of thickness.

The same measures in the Marsh pit gave 171 feet 7 inches, by which it appears that though there is some difference in the intermediate thicknesses, the total difference is only thirteen inches, while three of the coal seams have increased in volume.

Coal seam above the Captain seam.

A little over 200 paces down McPherson's Brook, from the slope on the Captain seam, another coal bed occurs, said to be about ten inches thick. It is exposed on the right bank of the brook, and is about 400 feet directly across the measures, from the out-crop of the Captain seam. Taking its inclination to be about 30°, which would be about the average of the angles in the trial-slopes on each side, its vertical distance over the Captain seam would be about 200 feet. On the Marsh Brook above the mill-pond, and about 600 paces from the north-west boundary of the McBean area, two trial-pits, about two chains apart, have been sunk by Messrs. McBean on the land of Mr. Jas. McDonald (Grayer). Mr. A. McBean describes the seam to be composed as follows:

Four-feet seam above Captain seam.

	Ft.	In.		
Cannel coal	0	4		
Mineral charcoal mixed with coal	1	0		
Good brilliant coal	0	8		
Coal bored through	1	9		
			3	9

The level course between the two pits is very nearly north, with a slope to the west, said to be about 1 in 6, or 9°, the low angle and irregular bearing of the dip no doubt arising from the circumstance that we are here approaching to the axis of the synclinal curve. The southern of the two pits is about 300 paces from the assumed south crop of the Captain seam; but having no means of determining the law of the curve it is not possible to calculate the vertical distance of the one seam from the other, nor to state what may be the relation of the higher one to the coal bed in the lowest position on McPherson's Brook.

Axis of synclinal.

Beyond McPherson's Brook the Captain seam appears to run along a dingle supplying a tributary streamlet, a quarter of a mile up which there is a red ferruginous spring,* which is supposed to give evidence of its presence at the foot of a steep rise on a farm road leading up into D. McPherson's fields on the top of the hill. Should this seam and those associated with it continue in the same course for half a mile farther, they would come against the great North upthrow fault, the effect of which, however, may possibly turn them a little south of west and continue their out-crop somewhat farther eastward; but of this there is as yet no evidence.

Red spring.

Contact of seams with North fault.

Somewhat over a mile south-west from the red spring, on the tributary of McPherson's Brook, and about thirty-three chains from the south-east boundary of their area, Messrs. McBean have sunk a trial-pit through eleven feet of drift and one foot of greenish-gray arenaceous shale, to a coal seam, of which the following is a section:

McBean's six-feet seam.

	Ft.	In.		
Cannel coal	0	1½		
Good coal	0	4		
Coarse coal and black carbonaceous fireclay	1	0		
Good coal of rather coarse texture	2	6		
Coal not so good, with hard shaly bands	2	6		
			6	5½

The crop of the seam rises in a small brook (the upper part of the Marsh Brook) about twenty feet to the south-westward, with a strike N. 37° E.; but a trial-pit sunk by Mr. Lawson on the crop about 160 paces north-eastward of the previous one, would appear to show the strike

Lawson's trial pit.

* The proximity of coal seams to the surface is so often indicated by red ferruginous springs, that these springs, called by Welsh miners *the blood of the coal*, are sometimes taken as a guide in the search for out-crops.

between them to be N. 47° E. Another trial-pit, sunk by Messrs. McBean, about 210 paces still farther on the strike and some distance across the measures to the south-eastward, shews a seam, the strike of which, as represented by Mr. J. McBean, appears to be again N. 37° E. Constructing the distribution of the seams from these elements, the vertical distance between them would appear to be about fifty-seven feet. The seam is said to be composed of six feet of good coal.

Another six-feet seam.

Conjectured equivalence of seams.

These two seams, being on the south rise of the Middle synclinal, are conjectured to represent the Mill-race and the George McKay seams, which they resemble in character, though both are much thicker. But the inferences to be deduced from this equivalence are of so much importance, as will be seen by the sequel, that it ought not to be taken for granted until the presence here of the whole group of the Marsh pit seams has been proved by trial-pits in a straight line at right angles across the measures; which probably would not be a very expensive operation, seeing that the drift in the vicinity is by no means very deep.

Trial-pits required to prove Marsh pit group.

McBean eight-feet seam.

At about 1450 feet across the measures, behind the lower of these seams, there occurs a bed of excellent coal of eight feet and a-half thick, on which Messrs. McBean have sunk a slope about five chains from the south-eastern and twenty-nine and a-half chains from the north-eastern boundaries of their area. The dip at the mouth of the slope is N. 55° W. $<$ 33°, and as far as observed the measures seem to preserve this inclination all the way to the six-feet seam above. This would give a vertical distance between them, at right angles to the planes of stratification, of about 800 feet, and the following is a rude approximation to a descending section of the ground as far as we have been able to ascertain the facts:

SECTION 6. (DIVISION B).

MEASURES BETWEEN McBEAN'S SIX AND EIGHT FEET SEAMS.

Measures above McBean's eight-feet seam.

	Ft.	In.	Ft.
Coal.—A seam conjectured to be equivalent to the *George McKay seam*			6
Black carbonaceous shale	40		
Greenish-gray conglomerate with silicious pebbles, varying in size from a quarter of an inch to two inches in diameter. This is not seen on the line of section, but at some distance to the eastward, and its true place may possibly be somewhat lower among the concealed measures	80		
Measures concealed	200		
Greenish-gray fine shaly sandstone	30		
Black carbonaceous shale only partially exposed	40		
			390
Coal—Coaly shale	2	8	
Good coal	0	4	
			3

Upper conglomerate.

Seam of poor coal.

	Ft.	In.	Ft.	
Light yellowish fireclay with *Stigmaria*	20	0		
Measures concealed	28	0		
Dark brownish-gray argillaceous shale, with six inches of black compact carbonaceous shale at the bottom, holding many well preserved scales of *Diplodus*, half an inch in diameter	4	0	52	*Diplodus* scales.
Coal—Good coal	0	10		
Coaly shale	0	2	1	Coal seam small
Dark gray underclay with *Stigmaria*, and bluish-gray fireclay	4	0		
Measures concealed	60	0		
Drab-gray fine grained sandstone partially exposed	20	0		
Measures concealed	30	0		
Greenish conglomerate with quartz pebbles, associated with fine grained sandstone, only partially exposed	30	0		Lower conglomerate.
Measures concealed	45	0		
Black shale, a band of which at the top is carbonaceous and is said to burn with a bright flame like oil shale	54	0	243	
Coal.—A seam reported by Mr. A. McBean to be probably here but of uncertain thickness			1	Reported coal seam.
Measures concealed	95	0		
Bluish-gray arenaceous shale	15	0	110	
Coal.—The McBean eight-feet seam			8	McBean eight-feet seam.
			814	

Behind the McBean eight-feet seam Mr. Lawson has sunk several trial-pits on the McBean area, and Mr. Robert Mitchell has sunk a number of others on the Mitchell and Barton area which adjoins it on the south-east. By these pits the measures have been partially tested to a horizontal distance of about fifteen chains, in which the inclination of the strata gradually increases from 33° up to 55°, while they remain very parallel to one another on the strike, and a descending section of the ground, at right angles to the plane of the beds, is as follows, as nearly as has been ascertained :

Lawson and Mitchell's trial-pits.

Steepening of measures.

SECTION 7. (DIVISION C.)

MEASURES BENEATH MCBEAN'S EIGHT-FEET SEAM.

	Ft.	In.	Ft.	In.	
Greenish-drab underclay with *Stigmaria*	3	0			
Measures concealed	6	0			
Yellowish-drab shaly sandstone	14	0			
Black and dark gray argillaceous shale	14	0	37	0	
Coal.—A seam of an inferior shaly character			3	0	Seam of poor coal.
Gray underclay	2	0			
Measures concealed	8	7			
Yellowish-drab shaly sandstone	4	6			
Black argillaceous shale	4	6	19	7	

		Ft.	In.	Ft.	In.
Small coal seam.	*Coal.*—Coal of inferior character	0	2		
	Good coal	0	1		
				0	
	Brownish-drab fireclay, with *Stigmaria*	2	3		
	Measures concealed	7	0		
				9	
Small coal seam.	*Coal.*—A seam of inferior quality			0	
	Gray fireclay	3	9		
	Brownish-drab compact sandstone	4	6		
				8	
Seam of very good coal.	*Coal.*—A seam said to be of remarkably good quality			2	
	Gray compact fireclay	5	0		
	Gray compact argillaceous shale, with some beds of fine arenaceous shale	10	0		
	Measures concealed	50	0		
	Gray argillaceous shale	4	0		
				69	
Olden's seam.	*Coal.*—This is called *Olden's seam.* It appears to be a black shining flaky argillaceous shale. It is not seen on the line of section but somewhat to the eastward, and this would be its place provided no fault intervenes			0	
	Gray fireclay	1	0		
	Measures concealed	68	0		
	Greenish sandstone, weathering drab	12	0		
	Measures concealed	37	0		
	Gray sandstone, weathering to a brilliant orange or rusty reddish-yellow from peroxyd of iron	16	0		
				134	
Small coal seam.	*Coal.*—Shaly coal	0	2		
	Good finely laminated coal	0	1		
				0	
	Light and blackish-gray sandstone, interstratified in alternating bands of about one-fourth and three-fourths of an inch thick	40	0		
	Light yellowish-drab rusty-weathering sandstones	14	0		
	Yellowish-gray and brownish-gray fine grained sandstone, weathering to an Indian-red	18	0		
	Yellowish-drab and dark gray red-weathering fireclay, crumbling into small fragments	32	0		
	Measures for the most part concealed, but two trial-pits show yellowish-drab brown-weathering or rusty-weathering sandstone, in wavy layers	247	0		
	Yellowish-drab arenaceous fireclay, weathering Indian-red	6	0		
	Measures concealed	80	0		
	Brownish-gray arenaceous shale, with dark brown bands in layers of from one to two inches	8	0		
	Black arenaceous very compact shale, with brownish-gray streaks.	3	0		
				448	0
				731	5

Crop of eight-feet seam to E.

Mr. J. Weir has traced the out-crop of the McBean eight-feet seam for about eighteen chains in a bearing N. 45° E. from McBean's slope to the south-east boundary of the McBean area. Here it bends a little more to the eastward, and it partially crosses the corner of the Mitchell and

Barton area where it seems to be interrupted by a fault, but the seam may possibly be found ultimately to be the same as that struck in Haliburton's pit on the St. Lawrence area, somewhat less than half a mile beyond, where it apparently comes against the great North fault. In the other direction from McBean's slope Mr. Lawson has sunk a series of trial-pits on the crop, tracing it in a bearing S. 37° W. for thirty-five chains, whence it gradually bends to S. 22° W. for between five and six chains farther. By this it appears that the crop runs unbroken for very nearly three-quarters of a mile on the McBean area. At the south-western end of this, however, it meets with a serious interruption in the occurrence of a great dislocation. This appears to produce an upthrow on the south side, but what the extent of the break may be has not yet been quite determined. The position of this break having been ascertained by Mr. Lawson, it is proposed to designate it by his name. In bearing it appears to be about S. 77° W., and in this direction it may have a connection with the Fulling-mill and the McGregor faults.

Crop of eight-feet seam to W.

Lawson fault.

If the measures are not interrupted by other disturbances, the Lawson fault would permit a much farther extension westward to the out-crop of the overlying six-feet than to that of the eight-feet seam, and by a series of trial-pits along the out-crop of the six-feet seam for the purpose of proving this, the increased workable extension of the eight-feet seam beneath would be proved at the same time.

If by a proper transverse examination in the vicinity of the six-feet seam this should be found equivalent to the George McKay four-feet, or any one of the Marsh pit group, it would of course be immediately inferred that the eight-feet seam will occur some 700 or 800 feet beneath the bottom of the Marsh pit, and its out-crop might thus be sought for near the mouth of the Marsh Brook.

Position of eight-feet seam on Marsh Brook

Although there are too many intervals of concealment on the lower part of the Marsh Brook, as well as between the six-feet on the upper part of the brook and the eight-feet seams, to permit an accurate comparison of details, yet it will be perceived by a reference to Section 2 (Division B), that at the depth of 789 feet beneath the George McKay seam there occur some bands of fireclay, and although no coal was seen associated with them, this would apparently be a favorable position in which a search for the eight-feet seam might be instituted. This spot is in the Pictou Mining Company's area, and the occurrence of the eight-feet seam here would establish its existence not only over the whole north-western part of the McBean area and carry it some distance on that of the company just named, but place it also under a considerable portion of the George McKay and other areas in the neighbourhood.

In the 730 feet of arenaceous measures which have been partially examined beneath the McBean eight-feet seam, Section 7 (Division C), there occur in the lower half many bands of sandstone which weather to various tints of red, giving them externally the aspect of beds belonging to the Millstone Grit, and without careful examination they might be mistaken for such. There are beds on McLellan's Brook, in the lower part of Section 3 (Division C), which have the same peculiarity, though by no means to the same extent, the effect of the weathering being to give the surface of the rock merely a mottled red and green colour. An instance of this is very conspicuous in a flagstone quarry on the top of a narrow ridge formed by a sharp turn on the right bank of McLellan's Brook, a little above Black's mill-site ; and it serves to assimilate the strata of the two localities.

Red-weathering sandstones.

Allusion has heretofore been made (p. 16) to five small trial-pits and bore-holes on the crop of a coal seam sunk by Messrs. McBean on the line between their first and second square miles (going south-eastward) about 250 paces from its south-western extremity. The dip is here southward ; but at the extremity of the line it appears to be northward. There is thus a synclinal form in the interval; and through this interval is supposed to run the Lawson fault, throwing the measures up on the south side. In the vicinity of the stake at the extremity of the line there are obscure evidences of the occurrence of a series of greenish-grey conglomerates with silicious pebbles. These conglomerates are better seen near the residence of Mr. Alexander McLean junior, where, as I was informed, the rock was met with in excavating the cellar of the building; and it occurs in two very small ravines between 200 and 300 paces westward. Similar conglomerates in a lower stratigraphical place are well displayed near the residence of Mr. Alexander McLean senior, at the foot of McLellan's Mountain, where the rock is intersected by a mountain brook to the east of the house. On this brook, Mr. Haliburton has tested two coal seams ; one above the lower conglomerates, by a trial-pit on what is said to be a four-feet seam, at the foot of the hill, and another a short distance on the rise of the hill, where a four-feet seam immediately under the conglomerates and their associated sandstones, is naturally exposed.

Synclinal form.

Greenish conglomerates.

Four-feet seam.

The dip of the conglomerates at the more northern position is about N. 43° W. $< 13°$; approaching the more southern conglomerates, it is about the same in direction, with an inclination of 19°, and at the out-crop, up the hill, the inclination increases to about 24°. Constructed from these elements as a guide, the following would appear to be a descending section of the ground, to which, of course, the amount of concealment must give some uncertainty :

SECTION 8. (DIVISION B.)

MEASURES INTERSECTED ON THE LAND OF MR. A. McLEAN, SEN.

	Ft.	Ft.	
Greenish-grey conglomerates with silicious pebbles of various sizes up to two inches in diameter, many of them consisting of white quartz..	85		Measures on A. McLean's land. Conglomerates.
Measures concealed..	22		
		107	
Coal.—A seam of which the *wash* is seen about fourteen chains to the westward of the line of section..		0	
Greenish-grey sandstone with much false bedding, seen about nine chains to the eastward	20		
Measures concealed..290	290		
		310	
Coal.—A seam sunk to by Mr. Haliburton, near McLean's barn, said to be		4	Four-feet coal seam.
Measures concealed..	25		
Greenish-grey conglomerate with silicious pebbles of various sizes up to two inches in diameter. This is not seen on the brook but to the westward of McLean's house..	37		
		62	
Coal.—A seam is supposed to be probable here		0	Supposed coal seam.
Grey arenaceous underclay with *Stigmaria*........................	3		
Greyish-drab flaggy sandstone	12		
Black carbonaceous shale	13		
Greenish-drab coarse conglomerates with silicious pebbles of various sizes up to two inches and a-half in diameter, in an arenaceous cement .	30		Conglomerates.
Yellowish-drab and greyish-drab flaggy sandstones with partings shewing carbonized plants	18		
Black carbonaceous shale	3		
Greenish-drab flaggy sandstone.......................................	16		
Greenish-drab coarse conglomerate, as before.........................	8		
Yellowish-drab flaggy sandstones and coarse conglomerates, partially concealed	55		
Dark greyish-drab moderately thick bedded sandstone with many impressions of plants..	5		
		163	
Coal.—A seam opened by Mr. Haliburton at the crop. This may be called *The Mountain seam*		4	Mountain seam.
		650	

By comparing Sections 6 and 8, it will be seen that there are two series f conglomerates in each, with no great difference of distance apart, while iere is nothing in the one section seriously contradicting the other, so far s known. Immediately beneath the lower conglomerates in Section 6, the ieasures are concealed, and these coarse beds may extend farther down; it the change in the sediments to carbonaceous shales a little lower would ake the base of the conglomerates appear to be a position in which a coal am might reasonably be expected. The discovery of such there would iuse the parallelism of the two sections to be more complete, and render search for the McBean eight-feet seam at the distance indicated between and the conglomerates in Section 6, a reasonable undertaking in the

Supposed place of the McBean seam.

vicinity of the Mountain seam. The vertical distance would appear to b from 150 to 200 feet. At an angle of 25° the horizontal distance woul be between 350 and 500 feet. But within this distance behind th

Contact of Mountain seam and South fault.

Mountain seam at McLean's, the whole of the productive coal measures ar probably disturbed or perhaps cut off by the great South upthrow fault very nearly to a contact with which, the Mountain seam can be traced west ward. It would therefore be necessary to follow the Mountain seam som distance to the eastward to get the space required, and the most convenien place would be in the vicinity of the St. Mary's road, about half a mil from McLean's, where the measures do not appear to be greatly covere up with drift.

Equivalence of conglomerates.

Should the coal seams which are above the summit of Section 6 prove, o proper examination, to be the Marsh-pit group, it would follow that th upper conglomerates beneath them would represent the sandstones whic underlie the George McKay seam at the Marsh Colliery, and to thes would also be equivalent the conglomerates at the summit of Section 8, b which it would appear that the break in the Lawson fault would excee

Break in the Lawson fault.

the distance between the George McKay seam and the one next above th Captain seam, or be over 370 feet.

Widow McLean seams.

Where the McBean eight-feet seam is interrupted by the Lawson fault it abuts against strata associated with a series of coal seams which hav been tested on McLean's Brook, where this brook runs through the lan of Mrs. McLean, a widow lady; they are in consequence known a the Widow McLean seams. The coal which has been obtained from ther is of inferior quality, and the seams are not known to have been met wit anywhere else. There is little doubt that they underlie the McBean eigh feet, but at what vertical distance there appears as yet no clue to deter mine. They have been traced from the McBean area to that of Mitche and Barton, where the highest of them crops out on the south side of St Mary's road, about forty paces south-eastward from McBean's corner-post

In their explorations, Messrs. Mitchell and Barton have not yet bee able to find these seams beneath the McBean eight-feet on the east part o their area, nor the eight-feet above them on the west part. The vertica distance to which they have tested the ground by trial-pits in the forme case is approximately given in Section 7 (Division C), where it appears t be about 730 feet, while that to which their researches have extende above and below the Widow McLean seams in the latter, as collected fror the correlation of their numerous trial-pits, and of natural exposures, i presented in the following descending section :

SECTION 9. (DIVISION C.)

MEASURES INTERSECTED ON AND NEAR McLEAN'S BROOK.

	Feet.	In.	Feet.	In.	
Light-grey very hard and tough underclay with *Stigmaria*...	2	0			Measures McLean's Brook.
Measures concealed	57	0			
Grey sandstone banded with dark brown streaks; the rock weathers rust-brown and holds *Stigmaria*	6	0			
Measures concealed	3	0			
Dark brown arenaceous shales, with carbonized impressions of *Cordaites borassifolia*	4	0			
Measures concealed	16	0			
Black argillaceous shale	5	0			
Measures concealed	35	0			
Grey arenaceous shales with ferruginous bands prevailing most towards the bottom, and weathering rust-yellow, while the rest of the beds weather a deep brown	6	0			
Dark grey arenaceous shale, with *Stigmaria* and *Cordaites borassifolia*	2	6			
Measures concealed	16	0			
Yellowish-drab fireclay, full of indeterminate *Calamites* casts, replaced by clay iron-stone	6	0			
Measures concealed	3	0			
Yellowish-drab fireclay, full of indeterminate *Calamites* casts, replaced by clay iron-stone	3	0			
Measures concealed	12	0			
Greenish-drab coarse grained sandstone, stained reddish-brown in the partings, which are full of carbonized comminuted plant-casts	4	0			
Measures concealed	20	0			
Light grey sandstone with argillaceous partings carrying indeterminate plants	5	0			
Measures concealed	32	0			
Black carbonaceous shale full of bivalve shells resembling *Modiola*	2	0			
			239	6	
Coal or coaly shale				3½	Small coal seam.
Measures concealed	10	0			
Dark brown arenaceous shales, the colour passing into black.	3	0			
Measures concealed	7	0			
Grey underclay with *Stigmaria*	4	0			
Measures concealed	120	0			
Light grey flaggy sandstone with black carbonaceous partings, holding *Noeggerathia*, casts of *Calamites* and other indeterminate plants	4	0			
Measures concealed	30	0			
			178	0	
Coal.—The Widow McLean ten-feet seam (so called.)					Widow McLean ten-feet seam.
Bad shaly coal	6	8			
Good coal	1	6			
			8	2	
Dark grey argillo-arenaceous underclay with *Stigmaria*	1	6			
Measures concealed	36	0			

		Ft.	In.	Ft.	In.
	Light grey arenaceous shale	2	0		
	Brownish-grey argillaceous and very ferruginous shale, approaching to a clay ironstone; the exterior weathers off in curved scales, as if from some concretionary structure, and the shale contains small indeterminate plant casts, resembling *Cordaites*	1	6		
	Blackish-brown arenaceous shale with black plant-casts; this is followed by blackish arenaceous shale with black carbonaceous partings, containing specks of mineral charcoal and presenting large forms of *Stigmaria* and impressions of *Sigillaria*, too imperfect for specific determination	1	0		
				42	0
Widow McLean thirteen feet seam.	*Coal.—The Widow McLean thirteen-feet seam* (so called.)				
	Coaly shale, in which occur interstratified laminæ of coal of from a twentieth to a quarter of an inch thick, with impressions of large forms of *Stigmaria*, with the stigmata or rootlet scars as large as a quarter of an inch in diameter	1	0		
	Good coal, much laminated	1	10		
	Dark fireclay	0	4		
	Coal with many bands of finely laminated shaly coal; it breaks in cleavage joints at right angles to the plane of bedding and shows laminæ of from a twentieth to a hundredth of an inch thick, with a very brilliant lustre. The planes of deposition are slickensided, as if from great pressure, and then lateral movement, such as would result from corrugation	9	0		
				12	2
	Light bluish-grey fireclay, full of black carbonized *Stigmaria.*	1	0		
	Measures concealed	5	5		
				6	5
Widow McLean third seam.	*Coal.—The Widow McLean third seam*, said to be inferior coal.			2	9
	Measures concealed			15	0
Widow McLean fourth seam.	*Coal.—The Widow McLean fourth seam*, said to be inferior coal			2	9
	Measures concealed	254	0		
	Yellowish-drab fireclay, having very distinct carbonized impressions of *Cordaites borassifolia*	6	0		
				260	0
	Coal.—Black argillaceous shale and fireclay mixed with coaly matter	3	3		
	Coal of a fair quality		9		
				4	0
	Bluish-grey fireclay with *Stigmaria*	1	0		
	Measures concealed	39	0		
	Brownish very compact sandstone	0	8		
	Very dark brown arenaceous shale, weathering blackish-brown.	0	8		
	Greyish-drab arenaceous shale or sandstone, resembling a fireclay, yielding readily to the weather and exfoliating in curved scales from the surface, as if from a concretionary structure	4	0		

	Ft.	In.	Ft.	In.
Greenish-drab conglomerate with a reddish tinge, perhaps from weathering; it holds pebbles of various sizes up to two inches in diameter, many of them of white and grey quartz and some of red sandstone	3	0		
Measures concealed	90	0		
Dark grey hard sandstone in even layers varying in thickness from one quarter to three quarters of an inch; they would be well suited for the purposes of tile-stones...	30	0		
Greenish-drab conglomerate with silicious pebbles....... ..	1	8		
			170	0
			941	0

While the general strike of the strata associated with the Mountain four-eet seam appears to be about S. 40° W., that of the Widow McLean group S. 8° W., and this divergence makes it seem probable that the diffi-ulty of the search for the McBean eight-feet seam between the two will e enhanced by a dislocation, the position and amount of which have yet be discovered. Probable fault.

The above section occupies a breadth of about 630 paces, in which the estward slope of the strata gradually increases from 30° at the summit to 8° at the base, and at a farther horizontal distance of about 280 feet across he measures to the eastward, in which the strata are concealed, there ccurs an exposure of red conglomerate, more resembling beds belonging the New Glasgow conglomerate or to the Mill-stone Grit than any seen nterstratified with the workable coal seams. This mass, of which I could ot determine the dip or strike, occurs on McLean's Brook, about 200 aces, following up the stream in a north-westerly bearing, from the pond f Mr. Finlay McDonald's saw-mill. From the head of the pond down to the nill there is a distance of about 200 paces in a direction nearly east, the trata in which are probably of the same character as the red mass farther up, and at the mill-dam coarse brick-red or Indian-red shales become xposed on the right bank of the brook, some of the beds of which display few disseminated silicious pebbles of a couple of inches in diameter. Red conglomerate. Red shales.

In the bed of the stream under the mill a band of limestone makes ts appearance. It is obscured by the refuse slabs ejected from the mill, out up in the cliff on the left bank it is again exposed, and here it has been quarried to a small extent. The limestone is brownish-grey in colour, nd holds obscure fossils, some of which are probably *Spirorbis carbonarius*. This band of limestone, which is limited on each side by coarse red shales, s eighteen feet thick, and some small portions of it seem to be made up of hard masses of limestone surrounded by greenish shale. The dip of the bed is N. 87° E. $< 55°$. Fossiliferous limestone.

About one hundred and twenty paces eastward another calcareous band runs up the cliff. It is about sixteen feet thick, and may be a

McDonald's limestone.

repetition of the previous one, either through an undulation or a dislocation, the dip being S. 72° W. $< 86°$. The strike in each case would be nearly north and south, but that of the strata farther down the brook appears, with many irregularities, to run more with the trend of the valley, which is nearly east. Somewhat under a mile down the valley, and about three hundred paces north of the brook, there is still another exhibition of limestone near the house of Mr. Finlay McDonald (sawyer.) Here the band is eleven feet thick, in very regular layers, which are interstratified with thin partings of shale. A copious spring issues from it, and the band can be traced for one hundred and twenty paces to the westward of the spring, with a general dip of N. 30° W. $< 75°$; while it is again met with in a bearing of N. 80° E., at a distance of about 250 paces from the same spot.

Millstone Grit rocks.

The rocks in the valley to the southward, judged of by two exposures on the north and one on the south side of McLean's Brook, are red shales, red sandstones, and red conglomerates, associated with greenish-drab sandstones and shales. Strata of a similar description are occasionally exposed in the valley all the way to Sutherland's River, and the whole bear a strong resemblance to the deposits of the Millstone Grit.

Strike of limestones.

The strike of the limestone, near McDonald's house, points towards the exposures near his saw-mill, and notwithstanding the irregularities which the latter display, the whole may belong to one and the same band. Supposing this to be the case, it is very evident that the trend of the strata associated with the limestones diverges considerably from that of the measures accompanying the Widow McLean and the McBean coal seams.

Absence of black shales at the surface.

At right angles to the McBean seam, there is between it and McDonald's house, a distance of three-quarters of a mile, and in this there has yet been discovered no evidence of the emergence of the great mass of black shales, which it has been previously stated abuts against the Mill-road fault, notwithstanding that the Lawson fault is a considerable upthrow to the south in the interval. It cannot be supposed that the Mill-road fault suddenly annihilates these black shales, and this disturbance being a downthrow to the eastward, the inference is that the shales underlie the arenaceous coal measures to the east of it; and as the strata associated with McDonald's limestones probably belong to the Millstone Grit series, it follows that they must be brought to the surface by some very great fault

Probable fault.

running at an uncertain distance north of McDonald's house. The course of this fault has yet to be ascertained; but one point on it probably occurs at the exposure of red conglomerate above McDonald's mill-pond.

It will be seen by the sequel that the thickness of the black shales can scarcely be much less than about 2000 feet. According to Mr. Hartley, the workable coal seams which have been tested on the west side of

he East River, are interstratified in an additional thickness of measures, equal to about 500 feet, and below these he states the occurrence of a series of arenaceous and argillaceous beds, without any very valuable coal seams, but still belonging to the productive measures, of which the volume may be 1000 feet more. It thus appears possible that without allowing anything for the New Glasgow conglomerates the great break which brings the Millstone Grit rocks to the surface at the east end of the coal field, may be an upthrow of at least 3500 feet; it will probably run across from the South to the North fault and it may appropriately be termed the great East fault.

Great break.

East fault.

Horizon of the Widow McLean seams.

The relation of the Widow McLean seams to the McBean eight-feet seam not having been as yet ascertained with accuracy, it is a question how far they may be beneath the bottom of the Marsh pit in the Middle synclinal. But as their outcrop has not presented itself on McLellan's Brook, it seems probable that they are sufficiently deep seated to abut, in their south rise, against the black shales in the Mill-road fault. The Widow McLean seams can therefore scarcely be expected to come to the surface in any other place than south-east of the McBean eight-feet seam ; but it would appear from a comparison of Sections 2 and 3 with Sections 6 and 7, that Messrs. Mitchell and Barton have as yet scarcely carried their researches far enough behind that coal seam to reach them.

It has been conjectured that the Widow McLean seams may be the eastern out-crop, in a deteriorated condition, of some of those workable seams which underlie the great mass of black shales. If such were the case, it would follow that the fault between them and the Mountain seam would be a much greater break than has been supposed by me, and the block of strata with which these seams are associated would apparently be a quadrangular mass limited by four great breaks, namely, the one just alluded to, the Lawson fault, the great East fault and the South fault. But until the search for the McBean seam behind the Mountain seam, and for the Widow McLean seams behind the McBean seam, has been exhaustive, it will be premature to speak with anything but doubt of the structure of this part of the coalfield.

St. Lawrence area.

Black shales.

Middle synclinal.

On the St. Lawrence area, black shales appear to have been obtained in nearly a dozen trial-pits, embraced in a space of about one hundred acres, lying southward of Haliburton's main shaft. The shales are characterised by the presence of an abundance of *Cythere*, with many small scales and minute bones of fishes, but it does not appear probable that the shales will have any very great thickness. Their position seems to be on a continuation of the axis of the Middle synclinal, and the measures may be expected to preserve on the whole a moderate inclination. Indeed Mr. J. Weir, formerly employed as pitman by Mr. Haliburton, pointed out to me a trial-

pit about one hundred and eighty paces from the main shaft in a bearin S. 20° W., where he informed me the measures were quite flat. It is tru that Mr. Brain, formerly Mr. Haliburton's overman, states in his manu script journal, with a copy of which Mr. Haliburton was so kind as t furnish me, that the measures in this same pit dip S. 20° E. (Mag.) < 30° but in a pit about seventy paces southward he registers the dip as N. 20° E. (Mag.) < 30°. In the interval the measures will naturally become flat so that there is no great discrepancy in the structure as given by the two.

Flat measures.

St. Lawrence coal seam.

The St. Lawrence main shaft is eighty feet deep, and according to Mr. Brain's register the coal was penetrated at a depth of forty-five feet It was there but three feet nine inches thick, but ten feet above the bottom of the shaft it had thickened to eight feet horizontally, while a fifty-six feet further down on the slope of the seam it became eleven feet one-half being good coal and the other coaly shale. At the depth of the shaft a gallery or level was cut in the coal twenty-two feet to the westward and eighteen feet to the eastward. A transverse drift was carried back from the shaft at a depth of seventy-five feet, and a bore-hole then driven at right angles to the slope of the measures, which dipped towards the pit at an angle of 75° ; in these, according to Mr. Weir, there were inter-sected the following strata :

Red shale.

	Ft.	In.	Ft.	In.
In the drift and shaft.				
White fireclay	9	0		
Red shale	7	6		
White fireclay	12	0		
			28	6
In the Bore-hole.				
White hard fireclay	12	0		
White soft fireclay	1	6		
Red shale	7	6		
White hard freestone	31	0	52	0
			80	6

North fault.

These details are given because they seem to indicate, by the tilted attitude of the measures and the colours of the strata, which are characteristic of the Millstone Grit series, that the face of the great North fault or of some immediate branch of it, must, at the depth of eighty feet from the surface, be close behind the bottom of the shaft.

Fault breaking McBean's eight-feet seam to E.

As previously stated, the out-crop of the McBean eight-feet seam on leaving the south-eastern boundary of the McBean area, and entering upon the Mitchell and Barton area, gradually bends round and assuming more of easting than shewn in its previous course, is supposed to be interrupted by a fault. The precise course of this disturbance has not yet been ascertained, nor is it definitely know whether it is an upthrow or a downthrow.

If it were the latter, its effect would naturally be to steepen the dip of the coal seam where in contact with it, and this dip, whatever its rate, would probably be northward. We see in the St. Lawrence pit that the effect of the North fault has been to produce a slope of the measures in an opposite direction, and it does not appear to me an improbable conjecture that the coal seam penetrated in that pit may possibly be the return of the eight-feet seam to the surface on the north side of a trough which lies between the two dislocations. It is possible also that the seam may abut against both these faults, and perhaps against the supposed great East fault, and thus shew no out-crop around the east end of the area which it may occupy, until it emerges near the St. Lawrence pit. After emerging, the out-crop gradually separates a little from the North fault in the neighbourhood of that pit; but as the fault gradually gains upon higher measures as it proceeds westward, the out-crop of the coal seam will again probably approach the fault and once more become concealed by it. Possible equivalence of the St. Lawrence seam.

If the fault which interrupts the McBean eight-feet seam were an upthrow, the coal bed in the St. Lawrence pit could scarcely represent it, and further facts would have to be ascertained before the true structure could be given. It may be remarked, however, that the eastward strike of McBean's six-feet seam on the upper part of Marsh Brook, which is conjectured to be equivalent to the George McKay seam, appears to run such a course, that it will probably come against a mass of conglomerate which occurs south-eastward from Mr. William Grant's house in that neighbourhood. This conglomerate is supposed to be the same as that which underlies the coal seam in question, as stated in Section 6. The dip of the measures is there northwestward, and the presence of the conglomerate in such a relation would, in reality, indicate an upthrow on the east side of a disturbance. If the course which this disturbance may present, should point to the eastward interruption of the McBean eight-feet seam, the upthrow of this seam might be considered as established. Upthrow fault.

About twelve chains from the north-east corner of the McBean area in a bearing N. 55° E. there is an exposure of greenish-gray conglomerate, dipping N. 43° W. < 40.° Were the fault an upthrow, this exposure would seem to represent the lower conglomerate of Section 6, and the crop of the McBean eight-feet seam would probably have the same relation to it on the east side of the disturbance, that McBean's slope has to the conglomerate on the west. Conglomerate.

The Mill-road fault, as has been stated, runs about S.S.E. from Black's mill-site on McLellan's Brook, and its course can be pretty well seen in the line of demarcation which it presents between the arenaceous measures on the east and the black shales on the west. But what its precise course may be, northward, or what effect it may produce upon the distribu- Mill-road fault.

tion of the measures in that direction, I have found no satisfactory evidence to determine. Arenaceous measures extend westward beyond the direct northern prolongation of the bearing given to the fault; but with a very little deflection westward the chief mass of sandstones would still keep on the east side, where they rise into a considerable hill, along the south-western foot of which the St. Mary's road runs to New Glasgow. The eastward prolongation of this hill appears to constitute the north-west limit of the Middle synclinal. The hill is supposed to have an anticlinal form, and rising on it to the north-eastward from Black's mill-site, we have some evidence of north-western dips on the land of Mr. Andrew Campbell. Near his house on the top of the hill is a well sunk through three feet of soil and thirteen feet of arenaceous shale and shaly sandstone; the dip, as explained to me by Mr. Campbell, was found to be N. 17° E. < 10°.

Arenaceous measures.

Anticlinal form.

N. W. dips.

Farther north-eastward the rocks are so covered with drift that I have not been so fortunate as to meet with exposures shewing slopes in the same direction, but evidences of a synclinal, whose axis would run on the other side of the hill until cut off obliquely by the great North fault, are met with under three-quarters of a mile north-eastward, where several coal beds have been worked to a small extent on Potter's Brook. The ground, however, is here so broken by faults running in various directions, while the amounts of displacement are not known, and so affected by minor undulations, that it is next to impossible to correlate the seams with one another with any degree of certainty.

North synclinal.

One of these seams occurs on the south side of the brook, where it was formerly worked by Mr. Alex. McKay, who informed me that the coal was of excellent quality, and who gave me the following section of the ground immediately beneath:

A. McKay's five-feet seam.

Calcareous underclay.

	Ft.	In.
Coal—A seam of excellent quality	5	0
Ash-gray calcareous underclay, characterized by a great abundance of well-preserved forms of *Stigmaria*	1	6
Ash-gray fireclay, becoming mottled with red by exposure to the weather, and holding *Stigmaria*	7	0
Coal—A seam of which the thickness was not ascertained	0	6
	14	0

The strike of the out-crop, as determined by the work on it, is about N. 62° W., with a slope to the north-eastward, but I am uncertain of the angle of inclination.

About 300 paces N. 20° E. from this, on the north side of the brook, a horizontal gallery was opened many years ago (the colliery was visited by me when it was in work in 1841) by the late Mr. Alex. Fraser, in a seam of excellent coal from four and a-half to five feet thick. The mouth of the

Fraser's five-feet seam.

gallery is about fifteen feet over the brook and immediately under the south side of the telegraph road. The gallery in its general course is about N. 82° W., and it extends about 120 paces under ground, with a sudden turn southward about thirty paces in. The dip is northward, but as the natural out-crop on the face of the bank presents an arch, first rising southward towards the road and then falling again beyond to the level of the brook farther down, it is evident that the horizontal gallery would turn at some uncertain distance beyond the extent to which it has been carried, and come out again to the crop in the bank at the same height of fifteen feet above the brook, shewing by this a fold over the axis of an anticlinal form or roll in the strata. On the south side of the brook, nearly opposite to this point, a slope sinks southward in what is supposed to be the same seam, and a rise in this on the south side of a synclinal might be expected to bring the seam into junction with that worked by Mr. Alex. McKay; but a fault appears to run between the two positions on or near the axis of the synclinal and renders the identification less certain. According to Mr. Poole, however, a calcareous underclay of twenty-two inches supports the Fraser coal,* and further assimilates the two seams.

Small anticlinal form.

Fault.

Calcareous underclay

Immediately east of the mouth of Fraser's gallery a fault occurs, and vertical strata met with by Mr. George McKay, in a pit sunk about 135 paces southward, shew the bearing of the fault to be about S. 16° E. About 140 paces eastward of this fault, and on the south side of Potter's Brook, Mr. Lawson has sunk a slope for the Pictou Mining Company in a coal seam of which the following is a section:—

Fraser's fault

Lawson's coal seam.

	Ft.	In.
Cannel coal, varying in thickness from three to nine inches	0	6
Mineral charcoal mixed with coal	0	2
Good bituminous coal, of which from four to six inches at the bottom appears to be of a friable character	3	0
	3	8

The bearing of the slope is S. 26° E., with an inclination of 20° for twenty feet; of 35° for eighty feet; of 20° for thirty-five feet, with a sudden diminution to 16° at the bottom, where a disturbance occurs running N. 52° W. This disturbance cannot, however, be a great one, as it produces little displacement at the out-crop of the seam; but at some distance farther to the deep of the seam (supposed to be about seventy paces from the mouth of the slope) a much more important dislocation probably occurs. Its position is inferred from the presence of about thirty feet of vertical sandstone about nine chains to the eastward of the slope, and a coal seam two and a-half feet thick, in a vertical attitude, about fifteen chains beyond; the

Small fault.

A larger fault.

* Transactions of the Nova Scotian Institute of Natural Science for 1863, p. 38.

bearing these would give to the fault is about S. 72° W. What displace ment this fault produces has not been ascertained, but a subordinate on appears to run parallel with it about eighty-five paces north of it, th bearing of which would bring it about twenty or thirty paces behind th mouth of Lawson's slope. Entangled with these disturbances ther appear to be two ten-inch seams of coal and several very small ones, i addition to the one of two and a-half feet just mentioned, the whole o which are supposed to be beneath the seam of Lawson's slope, and with i to lie in a narrow synclinal form north of the more important of the paralle faults.

Still another fault.

Ten-inch coal seams.

Comparison of coal seams.

Although the unknown amount of displacement produced by the faul at the mouth of Fraser's gallery prevents the stratigraphical relation o Fraser's and Lawson's seams from being accurately established, yet the character of the fuel in them has induced a comparison of the former with the George McKay seam and of the latter with the Mill-race seam. At any rate, it is but reasonable to suppose that these seams, with the rest of the Marsh-pit group, after cropping out on the north rise of the Middle synclinal, would, with the remainder of the measures, turn over to a northward dip and be found somewhere in connection with the synclinal of this part of Potter's Brook.

East river pit.

Eight-feet coal seam.

Fault.

Comparison with McBean's eight-feet seam.

About thirty chains from the telegraph road, on the old straight road leading to the Scotch church in New Glasgow, a pit has been sunk on the East River area, close by its northern boundary. According to information given me, it penetrates fourteen feet of drift, then fourteen feet of rock, the character of which I could not ascertain, and finally intersects a coal seam eight feet thick. At the bottom of the pit a slope was sunk for fourteen feet in the coal, at an angle of 60° in a bearing about south, to a face of sandstone cutting off the coal. The bearing of this dislocation I was not so fortunate as to learn; but a fault, of which Mr. Hartley has detected the presence on the west side of the East River, will run a little south of this, if it be not the same one. If Lawson's and Fraser's seams may be compared with the Mill-race and the George McKay seams, this one may be compared with the McBean eight-feet seam.

North fault.

The steepness of the seam here is no doubt due to the proximity of the great North fault, which passes about 120 paces behind it; but, after proceeding in this attitude for some distance westward, the strike of the measures appears to turn more south, while their slope diminishes. At a distance of about 700 paces from the pit, along the road near which it is situated, there is a descent in the surface, which runs about S. 30° W., and constitutes the north flank of a small but well marked ridge, which crosses the St. Mary's and telegraph roads just at their junction, and termi-

ates near the establishment of the Crown Coal, Brick and Pottery Company. The higher part of the ridge is composed of a brownish-drab sandstone of considerable thickness. This probably underlies the East River eight-feet seam, but at what vertical distance is uncertain.

Sandstone ridge.

At the Pottery works a pit was sunk to a three-feet seam of remarkably good coal by Mr. Jos. Richardson, and is hence called the Richardson seam, the measures intersected in the pit being as follows, with a dip of S. 57° E., < 19½°.

The Richardson three-feet seam.

	Ft.	In.
Drift	16	0
Grey argillaceous sandstone, gradually crumbling in the weather	24	0
Coal—The Richardson seam, of remarkable good quality	3	0
Grayish-drab fireclay, with abundance of *Stigmaria*	3	0
Light yellowish-drab fireclay	11	0
	57	0

These measures would underlie the mass of sandstone forming the ridge, and the out-crop of the coal seam would follow the foot of the rising ground up to the great North fault; where it crosses the road to the Scotch church there is a red ferruginous spring to mark its probable position; but in its south-westward course, the seam will probably be interrupted by a dislocation of which there is evidence at no great distance beyond the Pottery. The excellent quality of this coal gives it a resemblance to that of a bed two and a-half feet thick, which, as will be seen by Section 7, is about eighty feet beneath McBean's eight-feet seam.

Comparison of seams.

At Chisholm's mill-pond, on Potter's Brook, about thirty chains southward of the Pottery pit, an excellent seam of coal, said to be well suited for blacksmiths' purposes, and reported to have a thickness of three feet, was formerly worked by the Rev. Mr. Stewart, and is hence called the Stewart seam. The measures associated with it, as near as I could ascertain, are as follows, in descending order:

	Ft.	In.	Ft.	In.	
Black carbonaceous shale			10	0	
Coal.—The Stewart seam			3	0	Stewart's seam.
Gray underclay	3	0			
Measures concealed, but probably black carbonaceous or argillaceous shale	120	0			
Gray sandstone, weathering drab	5	0			
			128	0	
Coal and black argillaceous shale			0	1	Small coal seam.
Gray soft fireclay	1	6			
Gray hard fireclay with indications of *Stigmaria*	3	6			
Grayish-drab standstone	2	0			
Gray argillo-arenaceous shale	1	0			
Grayish-drab sandstone	4	0			

	Ft.	In.	Ft.	In.
Gray arenaceous shale	0	6		
Blackish argillaceous shale	0	6		
Gray flaggy sandstone	36	0		
Black carbonaceous and argillaceous shale, only partially seen	50	0		
			99	0
Coal.—Cannel (Small coal seam.)			0	11
Gray fireclay	3	0		
Black carbonaceous shale, only partially seen	105	0		
Grayish-drab sandstone	25	0		
			133	0
			374	0

Black shales.

The sandstone at the base of the preceding section is seen on the west side of the New Glasgow road, at the bridge over Potter's Brook; and proceeding down the brook from this, the cliff on the right bank gives a continuous descending section, in which nothing is met with but black shales. These have been carefully examined by Mr. Hartley, and the direct breadth of them in the bearing N. 80° W. which is at right angles to the strike, is computed to be very nearly 475 paces, with angles of inclination varying from 33° to 47°. This would give a thickness of about 700 feet, and if to this be added 500 feet for what may be concealed to the middle of the river, the distance being fifteen chains and the supposed inclination 30°, the thickness would not be less than 1200 feet.

Chisholm's mill-pond.

The strike of the Stewart coal seam across Chisholm's mill-pond and in the two or three crop-pits on the north side of it, is about N. 18° W., with an inclination to the eastward of about 30°; but a search for the seam in this direction, by trial-pits approaching the Pottery, has proved unsuccessful. In a cliff on the right bank of the East River, above the railway bridge, there is a considerable exposure of strata, which very probably underlie the seam at a considerable depth. About a quarter of a mile above the bridge, black shales, which are a part of the strata exposed, dip N. 40° E. < 23°—25°, and this dip is preserved on the strike for 300 paces; but approaching within 200 paces of the lower end of the bridge, the strata suddenly becoming arenaceous, plunge with a dip of N. 5° W. < 43°—45°, maintained for 150 paces measured directly across the strike, while close by the extremity of the bridge there appears to be a dislocation. This displacement, which may be called the Bridge fault, would seem to run a little south of the Pottery pit on the Richardson seam, and the sudden bend in the measures would carry the Stewart seam considerably out of its course to the westward, and thus, aided by the break, which is probably a downthrow on the north side, would bring it much nearer the river.

Arenaceous strata.

Bridge fault.

Southward from Chisholm's pond the measures appear gradually to assume a more westerly bearing, the strike becoming S. 20° W., and at

ne distance of between 300 and 400 paces from the pond they are interupted by another dislocation. The evidences of this were observed by Ir. Hartley on the right and left banks of Potter's Brook, about a quarter f a mile below the New Glasgow road, where the dip of the black shales ecomes S. 5° E. < 60°. The course of this fault seems to be about west; is a downthrow on the south side, supposed to be of about 200 feet, and n this side of it the black shales turn south-eastward and gradually conorm with the arrangement which they present on McLellan's Brook.

The great mass of black shales which immediately succeeds the band of andstone on the west side of the New Glasgow road at Potter's Brook eems to indicate that we have here the base of the arenaceous measures nd the summit of the black shales, and the position and arrangement of ne mass render it probable that it is to be considered an addition to the nickness which Mr. Hartley has found to exist at the highest horizon in nem on the west side of the East River, less the 200 feet repeated in ne Potter's-brook fault. Their volume over the Main coal seam (more articularly described in Mr. Hartley's Report,) is, according to him, 128 feet. If to this we add the 1000 feet occurring on and near otter's Brook, we have a thickness of 2128 feet.

Summit of black shales.

Thickness of black shales.

It has already been stated that McLellan's Brook, below Black's mill-site, resents a great body of these black shales, and on the East River, above ne mouth of this brook, there are farther exposures, reaching to the outrop of the Main seam, where a slope has been opened on it by the Pictou Iining Company. The whole will give to the series a transverse breadth f a little more than a mile and a quarter, with a north-eastward dip varying inclination from 8° to 24°. Such a computation as can be made from nese elements would assign to the black shales on the west side of the Iill-road fault, at Black's mill-site, a volume of 1740 feet. As this is 388 eet less than the total thickness stated above, it would follow that the isplacement produced by the Mill-road fault would equal this, with as much addition as the base of the arenaceous measures may be underneath the urface on the east side of the fault at that spot. As already stated, the recise course of this fault northward from Black's mill-site remains a atter of uncertainty; and whether it is deflected so far as to run for the ack shales at Potter's Brook and come to the East River near the railway ridge must continue a subject for future investigation.

Break in Mill-road fault.

Bearing of Mill-road fault.

The out-crop of the Main seam, upon which the coal works of the eneral Mining Association are situated on the west side of the East River, rosses the New Glasgow road about a quarter of a mile above the turn to ne Albion mines, and the slope of the Pictou Mining Company, which r the present is abandoned, is seen about 120 paces east of the road. s a detailed description of this seam, as observed by Mr. Hartley on the

Main seam.

Reference to Mr. Hartley's Report.

Strike of Main seam.

McLeod seam.

west side of the river. was necessarily to be a part of his Report, it wa left to him to follow the investigation of it and the seams and groun associated with it to the eastward. I shall therefore refer to him fo what is to be said of it and of a shaft sunk to it on Grant's farm, further t the eastward. The strike of the seam from the Albion mines to the slop is about S. 70° E. (or S. 47° E. Mag.), the dip at the mouth of the slop being N. 20° E. (or N. 43° E. Mag.) < 19½° ; but here the out-cro turns a little more southward, and a trial-pit has been sunk on it a quarte of a mile farther, in the bearing S. 45° E., thirteen chains beyond whic it will come upon a fault, the course of which, as ascertained by Mr. Hartle on the west side of the river, is almost exactly east. About thirteen chain on the course of this fault a coal seam occurs on the south side of it, on th land of Mr. Donald McLeod. The following is a section of the seam, a given to me by Mr. Lawther, who sunk the trial-pit :—

	Ft.	In.
Coarse coal	2	6
Coaly shale in very thin layers	3	0
Good coal, or the best part of the seam	2	6
	8	0

The crop has been traced a distance of about 190 paces, and the dip o the strata is about N. 76° E. < 19°, black shale being above the coa seam, and sandstone supporting the underclay beneath. If this wer the Main seam the displacement of the fault would be an upthrow of 28 feet on the south side; but the character of the seam is more like some o those lower down, and the upthrow, therefore, is probably much greater.

South fault.

This is the only coal seam I could hear of that has been struck on th south side of the fault above mentioned. Between the trial-pit on the coa however, and the great South upthrow, which appears to pass a little sout of the house of Mr. Neil McKay, there is a space of a mile in breadth The strata striking south would run across this nearly at right angles to th direction of the South fault. If the coal seams reach so far it is probable tha they may be deflected somewhat to the west on approaching the upthrow; bu as already stated, it is not impossible that a southern portion of the spac may be occupied by rocks of the Millstone Grit series, brought into plac by a fault subordinate to the great one. I have no facts, however, on th east side of the East River, to shew how much this may be.

Black shales.

About 200 paces less than a mile from the run of the coal seam o Donald McLeod's land, and at right angles to the strike, a pit has bee sunk for water on the land of Mr. William McLeod. The pit is sixty-thre feet deep; no water was obtained, and judging by the *débris* lying abou the mouth of the pit, it penetrates nothing but black shale. A lump o asphaltum is said to have been obtained at the depth of twenty-five fee

it I presume it may have been oil shale, or highly carbonaceous shale. ne position of the excavation is on the road which crosses McGregor's ountain, and it is about 800 paces north of the South fault.

About 1400 paces still farther east, but, as is supposed, on the east de of the Mill-road fault, there is an old gallery or level on a seam of coal id to be three feet thick, over which rises a considerable thickness of black ale. The mouth of the level is seen at a great bend of McLellan's Brook, bout 240 paces above the Fulling-mill bridge, and a little over 300 paces orth of the South fault. The dip of the strata appears to N. 54° E. < 18°. Three-feet coal seam, above Fulling-mill.

About 300 paces farther up the bend of McLellan's Brook, but not more an 300 paces on the road which runs southward from the Fulling-mill idge, there is an exposure on the right bank of the brook, which would e on the east side of the Mill-road fault, and on the south side of the ulling-mill fault, but it is uncertain to what division it may belong. The ase of it reaches to within fifty paces of the Devonian rocks brought up y the great South fault. The following is a section of the strata in escending order:— Section of measures near Devonian rocks.

	Ft.	*In.*	
Greenish-drab arenaceous shale interstratified with layers of greenish-gray sandstone	22	0	
Black argillaceous shale with thin layers of sandstone	2	6	
Greenish-drab sandstone	0	6	
Black argillaceous shale	15	0	
Gray shaly sandstone	5	0	
Greenish-gray conglomerate with siliceous pebbles of various sizes up to an inch in diameter, in an arenaceous matrix	1	6	Conglomerates
Black shale	1	0	
Greenish-gray conglomerate as before, with some sandstone	6	0	
Dark gray shaly sandstone	10	0	
Greenish-gray conglomerate as before	2	0	
Greenish-drab sandstone	1	0	
Black shale	3	0	
Greenish-drab sandstone	0	6	
Black flaky argillaceous shale weathering to a light gray clay	0	6	
Greenish-gray sandstone with indications of *Stigmaria*	0	6	
Greenish-gray conglomerate, as before	0	3	
Grayish-drab sandstone	3	0	
Coal	0	0¼	Small coal seam
Greenish-drab sandstone with uncertain indications of *Stigmaria*, with greenish-gray conglomerate at the bottom	2	6	
Black argillaceous shale with much iron pyrites	2	6	
Greenish sandstone, mottled with red, probably from weathering,	15	0	
Reddish sandstone, in some parts approaching to a drab; the reddish colour is perhaps due to weathering	20	0	Red sandstone.
	114	3¼	

The colour and character of some of the strata of this section indu the supposition that the mass may belong to a lower horizon than t neighbouring strata on the south side of the Fulling-mill fault, though st to be classed with the Productive measures; and it may have been broug into the position which it occupies by some entanglement with the Sou upthrow fault.

Red rocks, west of East River.

No strata known of a certainty to belong to a lower subdivision of t Carboniferous group than the Productive measures have been as y observed along the South fault, between these and the Devonian serie though it is supposed that some red rocks which Mr. Hartley has noticed the west side of the East River may possibly be such. It is to be remarke however, that these red rocks appear to have the same eastward dip as t undoubted Productive measures above them, in so far as the McLeod co seam may be taken as guide; and they may represent a deeper porti of the Productive measures than seen elsewhere in this coal field, wi the exception of the New Glasgow conglomerate.

New Glasgow conglomerate.

No rocks having the typical character of this conglomerate appear have been brought to the surface by either the South or the East faul or by Mr. Hartley's West fault. This does not, however, disprove the possible presence beneath the whole of the Productive area abuttin against these faults and constituting the base of Dr. Dawson's Midd Coal formation, as inferred by Mr. Hartley.

Coal seams above conglomerate.

This inference seems to be supported by the presence, immediately the summit of the conglomerate, of the coal seam worked by Mr. Willia Fraser (Moose) for the burning of his limestone, and another said overlie it; and although the occurrence of these is not strengthened by t known existence of any of the larger workable coal seams in the Picto synclinal, the deposits of which have yet to be examined by the officers the Survey, it would not be surprising to find, in a country apparently broken by great dislocations, that the absence of the larger seams may due to a structure resulting from some of these faults, of as important character as those affecting the productive part of the field above Ne Glasgow.

Total thickness of Carboniferous rocks.

The total thickness of the Carboniferous rocks of Nova Scotia, measured by myself at the Joggins in 1843 is about 14,700 feet. Th Pictou series, in so far as our examinations have gone on the prese occasion, is in ascending order as follows:

	Ft.	*Ft.*
Millstone Grit rocks, according to Mr. Hartley's Section 1, without any allowance for the East River series of Section 2, which may be an addition wholly or in part......................		3773
New Glasgow conglomerate, as measured on the east side of the East River..		1600

	Ft.	Ft.	Ft.	Ft.
Productive coal measures:				
Measures on the west side of the East River, according to Mr. Hartley's Section 4			2453	
Measures on the east side of the East River:				
Black shales above Mr. Hartley's Section 4		1000		
Arenaceous measures of this Report.				
Section 3, Division C	924			
Section 2, Division B	819			
Section 1, Division A	223			
Strata above A	148			
		2114		
			3114	
				5567
				10840

When it is considered that in the sections above given on both sides of the st River we do not in any case, with the exception of the New Glasgow glomerate, suppose that we have attained either the bottom or the top the series to which it belongs, and that the subdivisions at the summit at the base of the whole Carboniferous group are wanting, though osits belonging to them are not far removed from the district examined, eems probable that the volume assigned to the Carboniferous rocks at Joggins will be fully maintained in the Pictou region.

I have the honour to be,

Sir,

Your most obedient servant,

W. E. LOGAN.

REPORT

OF

MR. EDWARD HARTLEY, F.G.S.,

ADDRESSED TO

SIR WILLIAM E. LOGAN, F.R.S., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY.

MONTREAL, 30th November, 1869.

SIR,—In accordance with your instructions of July, 1868, I devoted the remainder of the season of that year to the exploration of that portion of the coal field of Pictou, Province of Nova Scotia, which lies to the west of the East River, and now have the honour to present to you the following Report. Having been made aware that my investigations were to be more especially devoted to the productive portion of the measures, no detailed examination of the older and outlying rocks has been made, except in so far as seemed necessary for the proper definition of the limits of the productive coal area. My description of such rocks will, therefore, be somewhat incomplete. The presence of numerous faults or dislocations of strata, throughout this region, combined with the fact that it is covered with an unusual quantity of drift, renders accuracy in the preparation of sections and in the mapping of the outcrops of coal seams, a difficult task, and in many places the facts which it has been possible to obtain, will only enable me to show the general structure.

In the preparation of this Report, and of materials for a map, I have been greatly assisted by the records of various mining companies and of individuals owning or working the coal areas of this section, also by private and public railway surveys, land surveys, and in the case of working collieries, by such underground plans as I have been able to procure.

Acknowledgments for assistance.

I would here acknowledge the many courtesies received by me from those whom I have met in the course of my examinations. In all cases the fullest information has been granted, for which my sincere thanks

are due and I would especially acknowledge my obligations to the following gentlemen, for the information they have so freely given me:

Mr. H. Crosskill, Assistant Provincial Secretary; Mr. Avard Longley Chief Commissioner of Railways of the Province; Mr. J. Rutherford, M.E., Provincial Inspector of Mines; Mr. W. A. Hendry, Deputy Commissioner of Crown Lands; Mr. James Hudson, M.E., Chief Manager General Mining Association of London; Mr. Jesse Hoyt, General Agent of the Acadia Coal Company of New York, U. S.; Mr. James Dunn, General Agent of the Intercolonial Company of Montreal; Mr. Truman French, Agent of the Nova Scotia Coal Company; Mr. J. P. Lawson, Mining Engineer, New Glasgow; Mr. J. B. Moore, Contractor for the Intercolonial Coal Company's railway; Messrs. Hanning, Civil Engineers, in charge of the construction of the same railway; Mr. William Barnes, Mining Engineer of Halifax; Mr. R. G. Haliburton, Col. R. B. Sinclair, Mr. L. R. Kirby, of Halifax; Mr. Daniels, of Pictou Mining Company; Mr. W. B. Leather, C. E., of New Glasgow; Mr. A. P. Ross, of Pictou; and Mr. J. Weir, of Pine-tree Brook.

Especial attention is called to the kindness of Messrs. Hudson, Hoyt and Dunn. At the Albion mines I have not only had Mr. Hudson's permission to examine and copy many valuable records and drawings, but he has presented the Survey with complete copies of his extensive underground plans, copies of drawings and specifications of machinery, and of private surveys made for the General Mining Association. By his permission, most satisfactory information was given me in my examination of the machinery by Mr. Thomas Blenkinsop, engineer, and of the underground work by Mr. William Hall, underviewer, and both of these gentlemen I would especially compliment on their admirable management of the works under their charge. I would also remark that to the skill of Mr. Thomas Rutledge, of the same company, we are indebted for the admirable set of drawings presented by Mr. Hudson.

At the Acadia collieries also, I have been allowed by Mr. Hoyt full access to the company's records and plans, and am indebted to him for the aid of men, and for much verbal information useful in my survey. Information concerning machinery and underground work, has been freely supplied by Mr. William Blacker, general overman, as also much information of a general character. I would also acknowledge courtesies of a general character received from Mr. J. W. Clendenning of New York, President of the Acadia Coal Company, who was kind enough to allow me office room in the company's building. In the examination of the Intercolonial Company's works and area, I have been materially aided by the courtesy of Mr. Dunn, who furnished plans, records and information. By his instruction, Mr. James Wilkes, underviewer, and Mr. Joseph

Richardson, underground overman, have also given me full information concerning machinery and underground work. I have also been assisted by plans of the railways by Mr. Moore, and a record of pits and borings by Mr. Barnes.

The area examined is included between the East and Middle Rivers of Pictou, and extends laterally from the Conglomerate ridge, a prolongation of Fraser's Mountain on the north of New Glasgow, to the Fox-brook road between Coal Mines and Hopewell villages. The rocks observed may be included under the following heads: Area examined.

Rocks observed

1. Pre-Carboniferous.
2. Millstone Grit.
3. New Glasgow conglomerate.
4. Productive coal measures.

These rocks I now propose to describe, and will then treat of their distribution in this region.

1. PRE-CARBONIFEROUS.

Pre-carboniferous.

Between the East and Middle Rivers, on the northern ridge, there appears a series of metamorphic rocks, unconformable to the overlying Carboniferous, consisting of quartzites, felsites, altered slates, and conglomerates, in which I could find no distinguishing fossils. This series has however been observed by Dr. J. W. Dawson, and in his *Acadian Geology* he states that they are "probably of Devonian age." * Dr. J. W. Dawson.

Some of these masses are quartzites, extremely tough and compact, of colours varying from dark sap-green to blackish-green, and weathering to a rust-brown. Others are quartzites of similar colours, weather opaque yellowish-white, and appear quite free from iron; while others still are of a dark olive-green, and weather to a very dark blackish-brown. Quartzites.

Felsites varying from pistachio-green to olive-green, and weathering deeply to a rust-brown, are also found. These appear to be brecciated wherever met with, and although compact are always much shattered. Felsites.

A large portion of the rocks consist of altered slates, ranging in colour from dark olive-green to dull greenish-grey, and weathering from an opaque white to a rust-brown. It is difficult, in many cases, to distinguish between the slates and quartzites; in fact they seem to pass into each other by imperceptible gradations. Altered slates.

Two descriptions of conglomerate, and possibly a third, are associated with the series. The first is one in which both cement and pebbles are of a greenish-gray colour, and so nearly alike in hardness that in breaking a mass the pebbles and matrix are fractured evenly across. This rock is Conglomerates.

* Acadian Geology, p. 319 of second edition.

extremely hard and tough, and appears to pass into quartzite by a gradual diminution of the pebbles, which are themselves quartzite of a slightly lighter tinge than that of the silicious cement. The second conglomerate is seen but in one locality, on McCulloch's Brook, where it forms a bed of some twenty feet in thickness, but it is so much injured by weathering that scarcely more can be said of it than that some of the pebbles are of a vermillion red jasper, with a cement weathering to a bright brick-red.

Limestone of Waters's quarry

But one band of limestone of this series has come under my observation. This is seen at Waters's limestone quarry, at the end of the Smoky-town road, where it appears to be about twenty feet in thickness, included within quartzites and altered slates. This limestone is of excellent quality, and is of a white or bluish-white color, with a tinge of ochre-yellow in the cracks; it weathers to a dead white with a porcellanous lustre, the edges of weathered specimens showing some thin laminæ in relief, giving a surface resembling that of an oyster-shell.

Devonian ridge.

These rocks form a ridge on the north of that portion of the coal field which has been examined, and going west are first met with about a mile from New Glasgow bridge, on a considerable rise of ground known as Waters's Hill, and thence scattered exposures and the general character of the ground indicate their presence on this hill as far west as the Intercolonial Company's railway. Waters's limestone quarry is on the summit of this hill, and besides the limestone the green felsites are well exposed. The dip appears to be S. 17° W.* $<$40° but the measures are disturbed by a fault. In the railway cutting at the west end of the hill good exposures are met with of the quartzites and greenish conglomerate, with a general westerly dip at high angles, but the true stratification is rendered very obscure by numerous dislocations and irregular cleavages throughout the whole mass. From the railway bridge over Waters's Brook the altered slates and conglomerates are well exposed in the cliffs forming the banks of McCulloch's Brook all the way down to its junction with the Middle River. Here, with a direct breadth of about one-third of a mile northward from the junction, and bounded on each side by faults separating them from the newer strata, the rocks of this series cross the Middle River, on the left bank of which they form a low ridge, and on the mill-pond of the axe factory in that neighborhood occur the most western exposures that have been examined.

Millstone Grit.

2. MILLSTONE GRIT.

From widely extended examinations of the Carboniferous rocks of this Province, Dr. J. W. Dawson, in his *Acadian Geology*, has subdivided

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* The bearings in this Report are astronomical, the variation for magnetic north being 23° 15′ W. See note p. 6.

his system in Nova Scotia, into five "subordinate groups or formations," as follows, in descending order:*

Dr. Dawson's classification of Carboniferous rocks.

"1. *The Upper Coal formation*, containing coal-formation plants but not productive coals.

"2. *The Middle Coal formation*, or coal formation proper, containing the productive coal-beds,

"3. *The Millstone-grit Series*, represented in Nova Scotia by red and gray sandstones, shales and conglomerates, with a few fossil plants and thin coal seams, not productive.

"4. *The Carboniferous Limestone*, with the associated sandstones, marls, gypsums, etc., and holding marine fossils recognised by all palæontologists who have examined them as Carboniferous.

"5. *The Lower Coal measures*, holding some, but not all, of the fossils of the Middle Coal formation, and thin coals, not productive, but differing both in flora and fauna from the Upper Devonian, which they overlie unconformably."

Subdivisions wanting.

Provisionally adopting the above nomenclature, it would appear that the Carboniferous rocks which I have here met with, are all referable to the Middle Coal formation and the Millstone Grit. Subdivisions 1, 4, and 5, are wanting throughout the region examined, and in some places the unconformable Devonian rocks appear to encroach on the base of the Middle Coal formation without the presence even of the Millstone Grit.

Red, green and gray sandstones limestones and conglomerates

The Millstone Grit is here represented by a considerable mass of red, green and gray sandstones and arenaceous shales with mottled sandstones, of limestones more or less pure, and of coarse and fine conglomerates, the whole manifestly underlying the Middle or Productive coal formation. This will be best described by two sections of strata belonging to the series, which, as now given, are to be considered as representing the larger rock masses rather than the detailed strata of this subdivision; but as the Productive coal measures, where their limits are accurately known, always seem to be separated from this series by faults, while in some places at least, the subdivisions are unconformable with one another, it would not only be impossible to give a section graduating upward into the Productive measures, but it would also be imprudent to hazard an opinion as to the exact horizon which the sections occupy in the Millstone Grit.

Faults.

The first of these sections occurs on McLeod's Brook, lying to the west of the coal field, and affords a fair representation of a considerable portion of these rocks; but as the exposures, though frequent, are not continuous, it is to be regarded only as an approximation. The strata are given in descending order.

* Acad. Geol., second edit. p. 129 et seq.

SECTION 1.

Measures on McLeod's Brook.

MEASURES ON MCLEOD'S BROOK FROM GAIRLOCH ROAD TO MIDDLE RIVER ROAD.

		Feet.
1.	Reddish-grey, brick-red, and mottled sandstones in alternations; some bands of about an inch in thickness are a green conglomerate with quartzite pebbles	450
2.	Red sandstones	210
3.	Greenish-drab sandstones, weathering red; some bands are red throughout.	325
4.	Reddish-brown sandstones	380
5.	Mottled Indian-red and light yellow sandstones tinged with brown; the predominating colour is Indian-red, the yellow portions being usually only from a quarter to a half inch in diameter, and sometimes assuming a greenish tinge. This mass contains some bands of from three inches to two feet thick, entirely of red sandstone	100
6.	Red fine grained flaggy sandstones, interstratified with occasional thin bands of fine conglomerate. The mass is partly concealed	600
7.	Greenish-drab red-weathering sandstones, holding thin bands of a greenish conglomerate, with pebbles of quartzite up to one inch in diameter. The sandstones contain many arenaceous plant casts, some of them three inches in diameter, all being indeterminate	50
8.	Brick-red shaly sandstones and arenaceous shales in alternating light and dark beds	420
9.	Reddish-brown fine grained heavy bedded sandstones, not well exposed	460
10.	Chocolate-brown and brick-red shaly sandstones in alternating bands	100
11.	Brownish-red coarse brown-weathering conglomerate	45
12.	Brownish-red coarse flaggy sandstone similar to the last	40
13.	Red coarse conglomerates weathering dark chocolate-brown, holding quartzite pebbles up to six inches in diameter, and containing lenticular masses of coarse greenish-drab rusty-weathering sandstone	20
14.	Greenish-drab coarse conglomerates, alternating with coarse greenish-drab flaggy sandstones (tile-stones) in beds of from a quarter to half an inch thick, holding many indeterminate black plant casts in the partings.	13
15.	Coarse conglomerates, with pebbles up to an inch and a half in diameter, composed entirely of a green quartzite and altered slate, in a coarse argillo-arenaceous cement, the whole of a green or greenish-drab colour	140
16.	Red sandstones, varying in colour from chocolate-brown to Indian-red; as a rule they are fine grained, and show many carbonized plant casts, around which, for about the twentieth of an inch, the colour of the sandstone is changed to a light lemon-yellow, as if from deoxydation of peroxyd of iron	200
17.	Coarse conglomerates of a rust-brown colour, tinged with green; they have a silico-ferruginous cement, and hold pebbles of green and black quartzite, altered slate, and a few vermillion-red jasper pebbles; quartzite and slate pebbles reach eighteen inches in diameter and predominate; they have imperfect cleavage with the bedding. The whole are deeply weathered to a rust-red, and poorly exposed	220
		3773

The second section is seen well exposed on the East River, between the Culton farm and the bend of the river above McKay's Brook, south of the Albion mines. It is also in descending order.

SECTION 2.

MEASURES ON EAST RIVER ABOVE THE ALBION MINES.

Measures, East River above Albion mines.

	Feet.
1. Gray greenish-drab and Indian-red fine grained sandstones, interstratified in beds of from one to three feet in thickness	100
2. Indian-red compact sandstones, with partings showing many small scales of mica. The rock weathers greenish and is much split with cleavage planes	170
3. Dark Indian-red arenaceous shale	10
4. Green compact sandstones with micaceous partings, interstratified with several bands of fine grained compact red sandstone	50
5. Indian-red compact and shaly sandstones in alternations	140
6. Red highly calcareous sandstones, which in weathering become mottled with patches of greenish-gray	230
7. Chocolate-brown shaly fine grained non-calcareous sandstones	16
8. Red and green sandstones in alternate beds of from five to eight feet thick.	47
9. Indian-red compact calcareous sandstones	160
10. Red shaly sandstones. This mass contains several patches or lenticular beds of conglomerate with a red argillo-calcareous cement holding green quartzite pebbles up to three-quarters of an inch in diameter. The thin shaly beds show ripple-mark	25
11. Sap-green very compact and tough fine grained calcareous sandstone	6
12. Green and greenish-gray fine grained compact sandstones, much split with cleavage planes	18
13. Red compact sandstone	45
14. Greenish compact sandstone	10
15. Red and greenish sandstones in alternating bands	40
16. Red fine grained non-calcareous sandstone, with some shaly beds	315
17. Whitish-green coarse sandstones, which at the base become very coarse and pass into a calcareous conglomerate varying from two to six inches in thickness with limestone pebbles up to one-third of an inch in diameter	20
	1402

The lower portions of the Millstone Grit hold beds of ferruginous limestone, their thickness varying, where examined by me, from five to twenty feet, the general character of which may be exemplified by that of one seen on the East River, just above McKay's Brook. This is a compact limestone of a white colour, mottled with ochre-red argillaceous patches which weather to a deep chocolate-brown. White limestone.

At McKay's saw-mill, near the New Glasgow and Hopewell road, occur masses of an impure limestone of a deep Indian-red colour, weathering chocolate-brown, mottled with patches of a greenish tinge; of a coarse light greenish-drab rusty-weathering sandstone; and of a peculiar calcareous conglomerate or nodular limestone of a greenish-grey colour, weathering brown, the pebbles or nodules of limestone varying from one eighth to one half of an inch in diameter. Impure limestone. Nodular limestone.

Not far west from New Glasgow there are narrow exposures of strata belonging to this formation, but as these are believed to exhibit a want of

conformity with the formation which is to follow they will be more particularly alluded to further on. Other exposures occur further to the west on the south flank of Waters's Hill, and on McCulloch's Brook, and it seems probable that these may belong to outlying patches resting on the Devonian series.

Outlying patches.

These apparently isolated portions seem to dip to the south and southwest, pointing to the Productive coal measures but a short way in front of them, from which, however, they are separated by a great fault, and they may have originally belonged to a continuous mass rising from beneath the coal measures on the north side of the synclinal in which these are situated.

Fault.

Probably derived from such isolated portions of Millstone Grit are many boulders of mottled-red and green sandstone found in pits and cuttings near the Smoky-town road, and beneath a red drift on the Intercolonial Company's railway, just south of the bridge over Waters's Brook, a conglomerate of this series is met with holding pebbles of greenish quartzite and white quartz.

Largest area of Millstone Grit.

By far the largest area occupied by the rocks of this formation, in so far as examined, is bounded on the west by the Middle River, on the south by the Fox-brook road and extends eastward to the old Hopewell road as far as McNaughton's mill-pond on the upper part of McCulloch's Brook, and a straight line coinciding with a fault which runs N. 33° W. from the mill-pond through the village of Westville to a point in the neighbourhood of McCulloch's Brook about one half mile from the Middle River.

McLeod's Brook.

In this area McLeod's Brook, which joins the Middle River nearly half a mile above Alma mills, has a general upward course, somewhat oblique to the strike of the strata, of about S. 20° E. as far as Oliver's mill, a distance of two miles and three quarters, crossing the Gairloch road about a mile short of this measure. The strata between Alma mills and Oliver's mill appear to be arranged in two synclinal forms, a deep one on the north of the Gairloch road bridge, the east and west axis of which would approach the Devonian rocks already described, and a shallow one to the south, the axis of which may be half way to Oliver's mill.

Oliver's mill.

Synclinals.

Rocks of Section 1.

The rocks which have been given in Section 1, form the south rise of the north synclinal, where they have a direct transverse breadth of about a mile and a quarter, with angles varying from 20° to 43°, and a portion of these may be repeated in the south synclinal. The strata exposed at Oliver's mill-dam dip S. 57° W. $<$ 86°, and appear to be the vertical measures of a considerable dislocation, and about a quarter of a mile to the south of this mill a great east and west upthrow fault is supposed to run through the country, but south of its position the strata of this formation appear to constitute the subsoil for a mile and a-half to the Fox-brook road. It is probable that these may be lower than the strata of the McLeod's Brook sec-

Faults.

ion, but whether they are so or not, Section 2, exposed on the East River rom this dislocation to the turn of the river above McKay's Brook may be onsidered as representing them wholly or in part. The direct breadth f the strata included in this section is about thirty chains in a bearing N. 10° E., with angles of inclination varying from 40° to 60°, the top of he exposed section being at the line of the fault which would cross the Nova Scotia railway about one and a-half miles south of Coal Mines station.

3. NEW GLASGOW CONGLOMERATE.

On the west bank of the East River, at the New Glasgow bridge, there is exposed a series of coarse and fine conglomerates with occasional sandstones of colours varying from Indian-red to chocolate-brown. As a rule the coarser conglomerates are more common at the bottom, the finer at the top; but they both consist of the same materials, with a difference only in the size of the pebbles, which in the finer conglomerates do not exceed a quarter of an inch in diameter. New Glasgow conglomerate.

In the coarser beds however the inclosed masses are of all sizes up to three feet in diameter, and they are, with very few exceptions, derived from the rocks of the Millstone Grit, those of red sandstone and red shale predominating, while with them all the green, greenish-drab, chocolate-brown and mottled grey and brownish sandstones, with calcareous conglomerates and nodular and other limestones, have been recognised as constituting the mass. The only other pebbles are a few of quartzite and conglomerate of the Devonian rocks. Pebbles from Millstone Grit. Pebbles from Devonian rocks

These masses are inclosed in an argillo-arenaceous cement, holding a good deal of calcareous matter, which sometimes shews itself as a white crystalline calc-spar holding the pebbles together. The colour of the cement is an Indian-red, and this has served more or less to tinge the whole mass. The sandstones are exemplified by two beds of five feet each, of a shaly character and brick-red colour, which are seen at a distance of seventy and 120 feet respectively from the base of the section; but thinner lenticular masses and partings of red and dark-brown colours are common. Calcareous matter.

These rocks are visible along the margin of the river for a distance of 300 yards, with a direct breadth across the stratification of 610 feet, with a general dip of N. 10° W. $<$ 35° — 50°, giving a thickness of 450 feet; but on the opposite side, as you are aware, similar rocks stretch much farther down the river and greatly augment the volume of the formation to which the locality has served to give a name. Breadth exposed at new Glasgow bridge

Another exposure of these rocks occurs at Alma mills bridge on th Middle River, and the following is a detailed section of them in descend ing order :

Section 3.

M asures Alma mills bridge.

Conglomerates at Alma Mills Bridge, Middle River.

	Feet
1. Red conglomerates and red shaly sandstones alternating in beds of from two to six inches thick ; the sandstones vary in colour from Indian-red to chocolate-brown, and the matrix of the conglomerates is a calcareo-argillaceous sand containing besides Millstone Grit pebbles, many of green quartzite and altered green conglomerate..................	1
2. Measures concealed, probably the same	3
3. Red sandstones and conglomerates alternating as in 1..................	16
4. Measures concealed	1
5. Red very coarse conglomerates alternating with red coarse arenaceous shales; some pebbles in the conglomerates are six inches in diameter.........	8
7. Indian-red very compact sandstone, much split with cleavage planes......	3
8. Red coarse conglomerate with pebbles of various sizes up to two inches in diameter..	
9. Brick-red arenaceous shales and thin bedded sandstones	3
10. Measures concealed	3
11. Red very coarse conglomerate, holding many pebbles of Devonian rocks varying in size up to eighteen inches in diameter...................	7
12. Red coarse conglomerates with thin lenticular beds and partings of a brick-red coarse grained flaggy sandstone............................	1
13. Red fine conglomerates with red alternating arenaceous shales. The fine conglomerates hold Millstone Grit pebbles, mostly of red and dark brown sandstones; they have a brownish-red calcareo-argillaceous cement........	9
14. Red coarse conglomerate with pebbles up to about three inches in diameter, in a strongly calcareo-argillaceous cement in many places showing scales of white crystalline calc-spar..............................	4
15. Brick-red flaggy fine grained sandstones................................	16
16. Measures concealed	16
17. Red coarse conglomerate..	5
18. Light ochre-red arenaceous shale....................................	5
19. Red shale and red very fine conglomerates interstratified...............	5
20. Brownish-red shales and sandstones interstratified.....................	29
21. Measures concealed	36
22. Red coarse conglomerates, with pebbles up to eight inches in diameter (not well exposed)..	193
23. Red very coarse conglomerates with pebbles of all sizes up to twenty-six inches in diameter, with occasional lenticular layers of brownish and brick-red arenaceous shale of one or two inches in thickness..	283
24. Dark chocolate-brown shaly sandstones, and dark red fine conglomerates with pebbles of half an inch in diameter..........................	34
25. Measures concealed	23
26. Red shales and brick-red coarse soft sandstones alternating with one another	24
27. Red shales and red sandstones of a similar character, partially concealed..	21

		Ft.
28.	Red coarse conglomerate with pebbles up to two inches and a half in diameter	4
29.	Measures concealed, probably red shale	15
30.	Red coarse conglomerate	15
31.	Brick-red and chocolate-brown sandstones in bands of about a foot thick.	10
32.	Red coarse conglomerate with pebbles up to six inches in diameter	27
33.	Measures concealed	50
34.	Dark Indian-red arenaceous shale	26
35.	Measures partially concealed, probably red shale	22
		1,372

The conglomerates of this section are situated on the north side of the arrow mass of Devonian rocks which has been previously described. he exposures extend from a little above the bridge 580 paces along the argin of the river, nearly at right angles to the strata, which dip S. 0°—30° E. with an inclination gradually diminishing from 74° to 54° as e approach the Devonian strata. These present themselves within twenty aces of the highest conglomerate bed, with probably a fault between. oing northward from the bridge, after a concealed interval of somewhat nder half a mile, possibly underlaid by Millstone Grit deposits, we meet ith a similar series of conglomerates, with an opposite dip and more oderate inclination, N. 10° E. $<$ 5°—25°, which has a breadth of nearly a ile, giving a thickness of about 1400 feet. We have thus good evidence of n anticlinal form. The north limit of the Devonian rocks bears about N. 61° ., which being oblique to the strike of the conglomerates permits a greater xtension eastward of the north than of the south slope of the anticlinal; and is questionable whether the north side of the Devonian rocks runs so far in he bearing given as to completely interrupt the summit of the conglomeates on the north side. The strike of the summit, as determined by such xposures as have been met with, would seem to carry it to an uninterupted junction with the summit of the north-dipping conglomerates of ew Glasgow bridge. These rocks would thus appear to be connected ith an anticlinal form between a northern synclinal on the one hand, ying between New Glasgow and Pictou, and a southern one on the ther holding the Productive coal measures. Between the conglomerates nd the coal measures, as distributed in this part of the country, there runs great dislocation gradually cutting off the southern slope of the former n its course towards New Glasgow, where the northern slope alone emains; but on the north side of the dislocation, towards the Middle iver, the narrow mass of Devonian rocks is singularly thrust up through he exposed south slope of the conglomerates, without apparently in any ay affecting the anticlinal form except as being a protruded mass.

South dip.

Devonian strata.

Millstone Grit.

Anticlinal form.

Strike of summit.

Synclinals.

Devonian thrust up.

The New Glasgow conglomerate thus occupies a position intermediate etween the rocks of the Millstone Grit, of the ruins of which it is made up,

Base of productive measures.

and the Productive coal measures, and may be considered as the base of Dr. Dawson's Middle Coal formation.

In tracing this conglomerate west from New Glasgow to the Middle River, it appears along the northern flank of Waters's Hill to directly overlie the altered Devonian rocks of that locality, and to be partially reduced in thickness by unconformity. As no contacts are seen however this appearance may be produced by a series of dislocations bringing up the lower rocks and obscuring the Millstone Grit, which in other portions of the region intervenes between this series and the New Glasgow conglomerate.

Discordance with Millstone Grit.

But if we have here an evidence of a want of conformity between the Carboniferous and Devonian rocks, nearer New Glasgow there appear to be indications of a discordance between two of the subdivisions of the Carboniferous rocks themselves. On the north side of the old road to Frazer Ogg's quarry, running S. 77° W. from the Hopewell road near New Glasgow bridge, and on a small water-run skirting the base of the escarpment of the New Glasgow conglomerate, there is seen just north of the great fault which has been mentioned above, a short section of the red and greenish sandstones, red shales and nodular limestones of the Millstone Grit series dipping N. 47° E. $<$ 67°, and evidences of the same rocks with a similar resulting strike are displayed for 200 paces north-westward. Fifty paces to the northward of this section we have the base of the New Glasgow conglomerate dipping N. 3° W. $<$ 30°. These exposures would seem to give direct proof of the unconformity of the conglomerate with the rocks of the Millstone Grit, which unconformity we should naturally have expected from the presence of pebbles derived from rocks of the latter division in the former.

Productive coal measures.

4. PRODUCTIVE COAL MEASURES.

In describing the Productive coal measures, I shall first give the column of strata containing the Albion coal seams, as represented at the Albion and Acadia mines near the East River, with some remarks upon the same series of rocks at other points, and the changes which they undergo, illustrated by short sections.

Main and Deep coal seams.

The coal seams of the Pictou region are widely known, especially the Main and the Deep seams, respectively thirty-six and twenty-four feet in thickness. On the west side of the East River, the Main seam is the highest one worked, being succeeded in ascending order by a great mass of measures barren of coal seams, known in the region as the *black shales*, from the character of the rocks composing it on the East River and at the first series of pits at the Albion mines; though, as will be seen hereafter, partially represented in other parts of the region by sandstones and fireclays alternating with shales.

Black shales.

The following section will approximatively represent the column of trata at the Albion and the Acadia Mines on the East River, and on the .cadia Company's railway. The materials are taken from pit records, where racticable, supplemented by the few exposures of which I have been ble to obtain the exact position in the series.

It is to be regretted that the value of pit records is greatly injured by ie fact that usually a mere general character is given to the mass ientioned, as for instance *rock*, *sandstone*, *shale*, *fireclay*, without a tatement of the important characteristics of colour and texture. To repair iis defect, I have, where possible, examined the material taken from the its, in company with men employed in sinking them, and will, in such ases, give my own descriptions, taking the record merely for thicknesses. n many cases, where numerous alternations of strata have been met with, ie pit *débris* is so much mixed, that an attempt to separate the bands y means of it might lead to error, and in such cases the record is given ord for word, as received, a reduction to the true thickness at right angles the stratification being the only change made.

Defects of record.

Pit debris examined.

Down to the Third seam I am indebted to the records of the General lining Association, as kept by Mr. Henry Poole, while manager, and by Ir. James Hudson, the present manager; below the Third seam and above ie Oil coal, the detailed sections are from the Acadia Company's record, s kept by Mr. Hoyt.

Authorities.

The section commences with the highest seam of which the exact osition is known, as proved in a pit sunk by Mr. Hudson, on the bank f Coal Brook, and the measures are given in descending order.

Highest coal seam on W. side of East River.

Section 4.

Albion section.

Measures at the Albion and Acadia mines.

	Ft.	In.	Ft.	In.
hree-and-a-half feet seam.				
1. Coal and brown carbonaceous shale mixed..................	2	2		
Coal, said to be good, not exposed.........................	1	4		
			3	6
2. Measures partly concealed, the lower part black semi-carbonaceous shale, with a light brown streak..................	70	0		
3. Black carbonaceous shale, very compact, giving a nearly black streak..	6	0		
4. Black argillaceous and carbonaceous shales in alternating bands, not well exposed..................................	254	0		
5. Brown carbonaceous shale..................................	182	6		
6. Black semi-carbonaceous shale............................	66	2		
7. Brown carbonaceous shale..................................	19	6		
8. Black argillaceous shale..................................	9	5		
9. Brown carbonaceous shale..................................	521	0		
			1128	7

Three-and-a-half feet seam.

Black shales.

		Ft.	In.	Ft.	In.
Main seam.	*Main coal seam.*				
	10. Coarse coal	1	4		
	11. Good coal	4	3		
	12. Ironstone band	0	2		
	13. Good coal (worked at the Foord pits)	20	6		
	14. Coarse coal *	8	4		
				34	7
	15. Dark *Stigmaria* underclay; the thickness is not stated in the record; that here given is not fully exposed	1	9		
	16. Black argillaceous shales, with many bands of ironstone of from one-half to three-quarters of an inch in thickness, and at least two bands of arenaceous shale of about two or three inches thick, of a dark gray color	144	6		
	17. Brown carbonaceous shale†	1	10		
				148	1
Deep seam.	*Deep or Cage-pit coal seam.*				
	18. Bad coal	0	2		
	19. Good coal	3	7		
	20. Ironstone	1	1½		
	21. Coal of fine quality	3	5½		
	22. Shaly coal	0	8½		
	23. Good coal	3	9		
	24. Coarse coal	0	11½		
	25. Good coal	3	4		
	26. Inferior coal‡	5	10		
				22	11
	27. Measures concealed, and no pit records	98	0		
	28. Black carbonaceous shale	8	8		
				106	8
Third seam.	*Third seam.*				
	29. Coal, said to be good			5	7
	30. Measures concealed, probably shales, and fireclays with thin bedded sandstone	61	2		
	31. Fireclay	9	1		
	32. Hard sandstone	1	0		
	33. Soft sandstone	4	1		
	34. Fireclay	6	4		
	35. Black argillaceous shale	4	6		
	36. Fireclay	2	9		
	37. Black argillaceous shale	0	10		
	38. Fireclay	2	3		
	39. Hard sandstone	1	4		
	40. Soft arenaceous shales	6	2		
	41. Fireclay	0	3		
	42. Black semi-carbonaceous shale	7	6		
	43. Hard sandstone	0	6		
	44. Black argillaceous shale	5	3		
				113	0

* Nos. 5—14 are reduced from the Foord pit record.

† Nos. 16—17 are taken from Mr. Hudson's record of the Dalhousie downcast shaft.

‡ Nos. 18—26 are taken from Mr. Poole's journal.

	Ft.	In.	Ft.	In.	
Purvis seam.					Purvis seam.
45. Coal coarse and impure; it increases to five feet six inches one mile west			2	8	
46. Underclay with *Stigmaria*, a light colored fireclay	0	10			
47. Compact gray sandstone	4	5			
48. Fireclay	5	2			
49. Hard sandstone	2	7			
50. Fireclay	19	9			
51. Blue (bluish-gray) fireclay	4	0			
52. Compact sandstone	5	7			
53. Blue fireclay	6	5			
54. Compact sandstone	0	5			
55. Shale	0	5			
56. Fireclay	0	4			
57. Compact sandstone	4	2			
58. Fireclay	5	0			
59. Measures unknown	1	6			
60. Black argillaceous shale	7	2			
61. Fireclay mixed with *coal* (?)	7	7			
62. Fireclay with *Stigmaria*	5	8			
63. Bluish-gray flaggy sandstone	2	6			
64. Fireclay	0	3			
65. Gray sandstone	0	8			
66. Fireclay	11	8			
67. Black shale*	2	3			
68. Measures unknown; from poor exposures they are believed to be fireclays and thin beds of sandstone, generally of a yellowish-drab or brown color	31	8			
			130	0	
Fleming seam.					
69. Coal of a fair quality			3	3	Fleming seam.
70. Black carbonaceous shale			4	3	
McGregor seam.					McGregor seam
Upper coal.					
71. Good coal. First Bench	1	9			
72. Dark brown arenaceous fireclay parting	1	0			
73. Good coal. Second Bench	3	0			
Bottom coal.					
74. Impure Coal	1	4			
75. Good coal	0	10			
76. Impure coal	0	8			
77. Good coal	1	0			
78. Black carbonaceous shale	0	6			
79. Good coal	1	6			
			11	7	
80. Measure unknown, said to contain an impure *coal seam* of considerable thickness, not opened	186	0			Impure coal seam.
81. Sandstone	2	8			
82. Fireclay	9	2			
83. Brown fireclay and brown carbonaceous shale	9	2			
84. Black highly carbonaceous very compact shale	4	7			
			211	7	

* Nos. 31—67 are reduced from trial pits Nos. 1 and 2.

		Ft. In.	Ft. In.
Stellar seam.	*Oil coal or Stellar coal seam.*		
	85. Good coal	1 4	
	86. *Stellar oil coal*	1 10	
	87. Bituminous shale. *Oil shale bench*	1 10	
			5 0
	88. Underclay not stated, included in the next (89)		
	89. Black carbonaceous shale		15 2
Seam A.	*Seam A.**		
	90. Impure coal		11 0
	91. Yellowish-drab arenaceous underclay, weathering quickly to a light brown colour and holding *Stigmaria*	8 0	
	92. Light brown compact fine-grained sandstone	3 0	
	93. Measures concealed	66 0	
	94. Light brown fine grained very compact rusty-weathering sandstone	3 6	
	95. Light brown fine grained sandstone, split with cleavage planes	30 0	
			110 6
Seam B.	*Seam B.*		
	66. The crop only shows; it has never been opened, but its thickness is probably about		2 0
	97. Measures concealed, apparently light drab fireclays and sandstones		75 0
Seam C.	*Seam C.*		
	98. This has not been proved; it is an impure coal at the crop, the thickness is estimated at		10 0
	99. Light yellowish-drab arenaceous underclay with *Stigmaria*	15 0	
	100. Measures concealed	18 0	
	101. Yellowish compact sandstone with *Stigmaria* (?), weathering brownish-yellow and containing black shaly partings	10 0	
	102. Measures concealed	15 0	
			58 0
Seam D.	*Seam D.*		
	103. Seen at the crop; the thickness is unknown, say		0 6
	104. Measures concealed	5 0	
	105. Purplish or dull claret-red very compact sandstone; one layer is eighteen inches thick	4 0	
	106. Measures concealed; one or two exposures of arenaceous fireclay of a yellowish-drab color are seen	26 0	
			35 0
Seam E.	*Seam E.*		
	107. This is a very small unproved crop, and may be about		0 6
	108. Yellowish-drab sandstones and fireclays alternating with one another, some of the fireclays weathering to a reddish tinge. These beds are partially concealed	23 0	
	109. Claret-red compact fine-grained sandstone, much split in the cleavage planes	3 0	
	110. Light brownish or rust colored fine grained soft sandstone, with false bedding and cleavage joints	5 0	
	111. Light brown sandstone of a similar character, partially concealed	8 0	
			39 0

* Nos. 81—90 are reduced from records. Nos. 91—120 are taken from exposures.

	Ft.	In.	Ft.	In.	
Seam F.					Seam F
112. Impure coal seen at the crop, and from the width of the crop estimated at......................................			4	0	
113. Brownish-yellow arenaceous underclay with *Stigmaria*, passing downwards into a soft crumbling sandstone of the same colour..			9	0	
Seam G.					Seam G.
114. Coal not proved, estimated at............................			2	0	
115. Measures partly concealed, apparently yellowish fireclays....	13	0			
116. Measures concealed ; the drift shows the *wash* of a coal seam.	11	0			Coal wash.
117. Measures concealed, including two very indistinct crops of *coal seams* of small size..................................	72	0			Two small seams.
118. Brownish-yellow crumbling arenaceous fireclay with *Stigmaria*, immediately overlaid with a little *coal wash*, as if of a coal seam of an inch or two in thickness............	7	0			Coal wash
119. Dull claret-red sandstone, very compact and fine grained....	7	0			
120. Brownish coarse grained sandstones and arenaceous fireclays alternating with one another, badly exposed, estimated at..	40	0			
			150	0	
Total*			2452	11	

No single section or column can be given which will fairly represent the measures of the entire coal field, as very considerable changes occur in the character and size of the coal seams, and changes of a remarkable character are seen throughout the field in the rocks. Special descriptions of the coal seams at the different collieries, with one or two pit sections, will illustrate this. Perhaps the most remarkable instance in this coal field of a complete change in the character of the measures is that which occurs in the 1000 feet of strata immediately overlying the Main seam, between the Foord pits near the East River and the Forster pit, about a mile to the west. At the Foord pits, as will be seen by reference to the general section, the Main seam is overlaid by upwards 1,000 feet of black and brown shales, the lower portion of which is principally carbonaceous. Tracing this mass of black shales west, on Coal Brook we find the shales less carbonaceous, and many interstratified bands of clay iron-stone are included in the lower portion ; at the Dalhousie pits, they are the same, with some arenaceous black shales included ; and on the Forster pit railway, some very thin bedded, light drab sandstones become interstratified. No exposures exist between the Dalhousie and Forster pits, but as we go west we may trace, by means of the rocks brought into the underground working by a *crush*, a gradation from argillaceous black shales and iron-stones, through arenaceous black shales and arenaceous light coloured shales with

Horizontal changes in measures and coal seams.

Changes between Foord & Forster pits.

* Between the Deep and McGregor seams there are but few natural exposures, and as neither the Third nor Purvis seams are open at the present time, the general thicknesses as given, are liable to alteration on future explorations.

black carbonaceous partings, to thin bedded sandstones with similar black or brown argillaceous partings; while at the Forster pit we find the following descending section, including many feet of compact sandstone, often of a pure white colour.

Forster pit section.

SECTION 5.

MEASURES INTERSECTED IN THE FORSTER PIT.

	Ft.	In.	Ft.	In.
1. Dark grey sandstone, the *post* of the miners	13	9		
2. Yellowish drab fireclay varying to brown	2	3		
3. Black argillaceous shale		6		
4. Yellowish-drab fireclay	2	3		
5. Black argillaceous shale	19	9		
6. Dark brownish-grey shaly sandstone, passing into argillo-arenaceous shale holding calcareous matter; it weathers soon to a rust-brown colour	8	6		
7. Bluish-grey argillaceous shale	2	8		
8. Dark grey sandstones and shales similar to 6	20	2		
9. White sandstone, sometimes shaly, often compact, in beds of from three to four inches. The shaly portions have some black carbonaceous partings	1	2		
10. Dark brownish-grey sandstones and shales similar to 6	32	4		
11. Black semi-carbonaceous shale	81	0		
12. Brown carbonaceous shale	54	0		
13. Dark brownish argillo-arenaceous shales. They are composed of interstratified layers of black and white arenaceous shales, very thin and loosely bedded. They are strongly calcareous, and in similar shales in other parts of the field, I have seen small lenticular masses of pure white limestone up to an eighth of an inch in thickness and three or four inches in length	93	4		
14. Brown carbonaceous shale, the *black bat* of the miners	6	3		
15. Light grey argillo-calcareous shale, containing a great deal of iron. It weathers to a very bright iron-red on surfaces of deposition, and rust-brown on fractures. Some portions of this mass may prove a workable ironstone	54	0		
			391	11
Main seam.				
Coarse coal	2	3		
Good coal	2	3		
Dark brown arenaceous fireclay parting	1	1		
Good coal	8	9		
Dark brown arenaceous fireclay	2	9		
Good coal. This part is worked	19	9		
			36	10
			428	9

Main seam.

Faults bounding the coal field.

The Productive coal measures in the district under consideration are included between two great upthrow faults on the north and south sides, and they are limited on the west by a third. These faults have already been incidentally alluded to in the description given of the distribution of

he lower rocks. One of the dislocations, to which you have given the ame of the North fault, passes through the town of New Glasgow, where, n the west side of the river, it brings the lower portion of the coal meaures against a small area of Millstone Grit deposits, just at the base of the Jew Glasgow conglomerate. Thence it passes in a course of S. 88° W. ear to the north-west corner of the General Mining Association's area, in hich vicinity it turns more to the south-west, and from the Smoky-town oad to the Middle River its course is about S. 72° W. In this bearing, o within a mile of the Middle River, it brings the Devonian series, with outying patches of Millstone Grit, against the coal measures, but farther on its ffect is diminished by the fault forming the western boundary of the oal field. This disturbance it is proposed to designate as the West fault. The general course of this dislocation, and its position, as well as the osition of the great southern upthrow which you have named the South ault, have been indicated in the description of the limits of the principal reas of Millstone Grit.

North fault.

West fault.

South fault.

Within these boundary lines the coal measures are arranged in two ynclinal forms, the axes of which, about a mile apart, run in a general ast and west direction. The first and larger of these will be designated he Albion synclinal. It has perhaps a subordinate undulation near its centre, but the exposures which would seem to indicate this may be brought into place by a considerable fault known to exist in their vicinity. The Albion synclinal extends laterally from the town of New Glasgow to the Albion and Acadia (Fraser) mines, near the East River ; and to the south of this is the second trough, to which will be given the name of the Bear-creek synclinal. Both of these are limited at their western ends by the West fault, and while the area of the workable coal in the Bear-creek synclinal is limited to the east by a dislocation, probably not throwing out the lower portion of the coal measures entirely, the Albion synclinal* extends eastward across the East River, beyond the region of my examination.

Albion synclinal.

Bear-creek synclinal.

The only important group of coal seams included in the measures on the west side of the river, is that of the general section (Section 4), and as these seams have been most extensively worked, and are therefore best known at the Albion mines near the East River, it would seem best to take these workings as a starting point in describing the general distribution of the group.

Albion group of coal seams.

Distribution.

From the oldest workings on the west bank of the Little branch of the East River the out-crop of the Main seam, which in these workings has a dip of N. 22°—30° E. (or N. 45°—53° E. Magnetic) <18°—23°, crosses

Out-crop of Main seam eastward.

* This is the Middle synclinal, and the subordinate undulation gives the North synclinal of the previous Report.

Pictou Mining Company's slope.

the East River, and curving slightly south-eastward enters the area o the Pictou Mining Company. About half-a-mile in a bearing S. 70° E from the west bank, a slope was sunk by the company mentioned upon th Main seam; but the coal proving of inferior quality the workings hav been abandoned. The dip is here N. 35° E. < 19°, and a section of th seam as taken by Mr. Thomas Lawther when in charge of the mine as over man, and given me by him is as follows:—

	Ft.	In.
Shaly coal, known as *strong coal* by the miners.............	2	0
Coal and black carbonaceous shale............................	8	0
Shaly coal..	2	0
Black carbonaceous shale, with coaly matter in the partings..............	10	0
Shaly coal, worked..	1	0
Good coal, worked	2	0
Shaly coal, worked..	1	0
Poor coal, not worked, about................................	12	0
	38	0

Pit on Grant's farm.

About twenty-eight chains from the slope, in the bearing S. 73° E. and 308 yards from the crop across the strike of the strata, which is here S. 25° E., a pit was sunk 350 feet to the top of the Main seam, and a few feet into the coal, which proved of inferior quality, in consequence of which, after boring through the seam, this shaft also was abandoned. As the strata sunk through in this pit shew a change in the character of the measures between this point and the Foord pits, equally remarkable with that between the Foord and Forster pits, the following section is given after an examination of the pit *débris* in company with Mr. Lawther, who had charge of the sinking, and has furnished the record of the thicknesses of the different beds:—

SECTION 5.

Measures in pit on Main seam.

MEASURES INTERSECTED IN THE PICTOU MINING COMPANY'S PIT ON THE MAIN SEAM, GRANT'S FARM.

	Ft.	In.
Black carbonaceous and argillaceous shales in alternating bands; the only fossil observed is *Cordaites borassifolia*..........................	94	0
Dark gray sandstone alternating with white arenaceous shales having black carbonaceous partings, and showing many indeterminate carbonised plants; in some beds the partings exhibit ripple-marks. In weathering, the arenaceous shales do not change their colour, while the sandstones weather different shades of gray, through brownish-gray to dark brown, some bands shewing a reddish tinge. The whole mass contains occasional thin bands of clay ironstone.......	58	0
Black argillaceous shale..	101	0
Dark gray close grained sandstones with white arenaceous shales similar to the second bed of the section; near the middle of the mass a band of dark gray sandstone was sunk through of an exceedingly close grain which weathers to a dull orange-drab......................	37	0

			Ft.	In.
Black carbonaceous shale			7	0
Dark gray heavy bedded sandstone interstratified with dark gray shaly sandstone having some black carbonaceous partings			14	0
Black argillàceous shale			1	0
Main Seam.	Ft.	In.		-
Coarsely laminated coal, known as *coarse coal* by the miners	2	5		
Dark gray fireclay full of *Stigmaria*	2	10		
Shaly coal and black carbonaceous shale	9	6		
Coarse coal	1	7		
Dark gray fireclay with *Stigmaria*	2	4		
Bad coal, bored through	6	7		
Dark fireclay, bored through	3	0		
			28	3
			340	3

The McLeod fault.

McLeod seam.

Immediately to the rise of this shaft a trial-pit has been sunk on the ɔp of the Main seam, but beyond this the seam has not been traced ıthward. In a few chains however it is probably thrown considerably the eastward by a fault having an east and west bearing and producing upthrow on the south side. To the south of this fault one coal seam ly is known ; it is on the land of Mr. Donald McLeod, and with a thick-ss of eight feet, strikes S. 15° E., the dip being eastward at a moderate gle, but it is not at present known what coal seam of Section 4 this one presents. The dislocation which brings it into place will be designated the McLeod fault.

Deep seam.

In the triangular area between the crop of the Main seam and the dislo-tion just mentioned, bounded to the west by the East River, only one seam s been opened. It is the Deep or second seam of the Albion group, on e crop of which a trial-pit was sunk by the Pictou Mining Company ; but e coal is said to be of very poor quality.

Coal seam.

South fault.

Bear-creek synclinal.

The crop of a seam underlying this is seen on the east side of the Spring-le road, in a small stream crossing the road about half-a-mile to the uth of the crop of the Main seam, but its position in the coal series nnot be stated with certainty at present, as it lies to the south of the cLeod fault. Beyond this disturbance the measures are supposed to rn slightly to the west of south, and then again curving round to a south-stward strike, they will, if not lost on some dislocation as yet unknown, finally cut off by the great South upthrow fault of McGregor's Moun-in. The westward curve of these measures shows the existence of a allow synclinal on the eastern prolongation of the axis of the Bear-eek synclinal* presently to be described.

This synclinal appears to correspond with the South synclinal of the previous Report.

Out-crop of Albion seams westward.

Returning to the west side of the East River, the workable seams fro the Main to the McGregor are known near the river bank. The undergrou workings of the Albion mines prove the exact position of the Main a Deep seams for about one mile and a quarter west from the earliest wo ings. From these, now known as the Burnt mines, the strike and the ang of dip continue regular to the Dalhousie and Cage pits, where the dip N. 22° E.<20° at the crop of the Main and Deep seams in the bed Coal Brook ; thence the line of the crops of these seams turns to a mo westerly strike, the dip at the crop of the Main seam to the rise of t Forster pit being about N.<30°. Farther west the strike curves slight to the south-westward, while the angle of inclination is considerab reduced, the dip at the McKenzie pit on the Deep seam near McCulloc Brook being N. 23° W.<15°.

Dalhouse and Cage pit.

McKenzie pit.

Third and Purvis seams.

The Third and Purvis seams are known near the river by trial-pits su by the Acadia Coal Company, and to the west nearly as far as McCulloc Brook by the Third seam slope near the north line of the Fraser are thirty-nine chains from the north-west corner-post; and by the Purvis on the north side of the old post road to the Middle River, about twent two chains eastward of the McKenzie pit.

McGregor seam

The McGregor seam has been traced from its out-crop on the bank the East River about 115 chains west by trial-pits and the workings of t McGregor colliery, and a crop on McCulloch's Brook is believed to sh the position of the seam still farther west.

Stellar seam.

The most extensive working of the Oil-coal or Stellar seam is from t Fraser mine of the Acadia Coal Company, near the crossing of that co pany's railway on Coal Brook, from which opening its crop is known ea ward to a point near the New Glasgow and Hopewell road, about forty-fi chains. Here the out-crop of this seam approaches the run of the dis cation which has been called the McLeod fault, and it is probable that cannot be traced much farther in a south-east direction. To the west the Fraser mine the course of this seam has been proved to the Stell mine or Oil-coal slope on the east bank of McCulloch's Brook, where dips W. <13°, shewing this position to be near the axis of the anticli between the Albion and Bear-creek troughs. The seams and the associat measures which are placed below the Stellar in Section 4 are seen only the Acadia Coal Company's railway, the lowest appearing in the railw cutting about twenty-five chains eastward from the McCulloch's Bro bridge, immediately to the south of which exposures runs the McLe fault, bringing up still lower rocks. Their position in the Carbonifero series is as yet not accurately known.

A short distance to the west of McCulloch's Brook, and nearly parall with its course from the Stellar mine to the McKenzie pit, a considerab

ocation exists, having a run S. 22° E, with a western downthrow; the nt of this is not exactly known, but it would appear to be about 1600 where the crops of the Albion group of seams are lost. This dislocation be called the McCulloch-brook fault. A short distance to the south he Stellar mine the break in this fault is considerably increased by of the McLeod fault. It has already been observed that the measures he south of the McLeod fault have not been sufficiently examined nable their horizon to be stated with certainty, and but few exposures t between this fault and the great South fault; the rocks however, re seen, appear to be light drab and reddish-grey sandstones with ny thin beds of black flaky fireclay, some of the sandstones weather- to a deep Indian-red, somewhat resembling the red sandstones of the lstone Grit series. The general aspect of these strata, however, is not cisely like any mass of rock known to belong to that series, and as the est portion of the strata in question, where exposed near the East River, e a resemblance to some beds of yellowish-white sandstone seen on the nt bank of the river below New Glasgow bridge, in geological position nediately overlying the New Glasgow conglomerate, we may provision- consider the rocks in these two places as occupying a proximate horizon, nely that of measures between the conglomerate and the workable coal ms.

McCulloch-brook fault.

Red Sandstones.

Geological horizon.

Between the two bounding faults these strata are arranged in a shallow nclinal form corresponding with that to which, as you have informed me, ı have given the name of the South synclinal on the east side, and the ne as that designated by me as the Bear-creek synclinal on the west side the East River.

The McCulloch-brook fault cuts off the crop of the Main seam near mall water run, a few chains to the west of McCulloch's Brook. On down-throw side of the break the general dip of the measures is changed t little near this point, but on proceeding south we find near the south- stern portion of the Carmichael area of the Acadia Coal Company at the strata pass over an anticlinal, the dip becoming flat, and en southerly, while in the centre of the eastern portion of the Bear- eek area of the Intercolonial Coal Company the measures again tten, and finally assume a northerly dip as we go south. The anticlinal ar the south line of the Carmichael area is the continuation westward of e form on the north dip of which the Albion mines are situated, while the nclinal is in continuation of your South synclinal, and is the form to hich I have given the name of the Bear-creek synclinal.

Break in Main seam.

The strata which are brought up by the fault against the Main seam of e Albion mines are believed to represent a series of black shales above e Three and a-half feet seam at the summit of Section 4, which have been

Three and a half feet seam.

observed elsewhere only to the east of the East River on Potter's Brool The angles of inclination to the west of the fault are not sufficient to brin the Main seam and those below it to the surface, and therefore in tracin the McCulloch-brook fault to the south-eastward, out-crops of these seams d not appear until the south rise of the Bear-creek synclinal is reachec where they are supposed to leave the fault with a westerly strike. Th exact line of this fault is not known on the No. 3 area of the Acadia Co: Company, which lies to the south of the Fraser area, but it is believed t continue in the general course of S. 22° E., which it is known to have nea the Stellar mine.

Culton seam.

Six feet thick.

Fossils.

On the No. 3 area the black shales overlying the Main seam have bee proved by a few trial-pits, but no coal seam has been found between th McCulloch-brook fault and the stream itself on the south rise of the Bear creek synclinal. On this brook, on the Culton area of Messrs. Sinclair an Haliburton, about six chains south of the north line of the area, an openin has been made upon a coal seam locally known as the Culton seam. Her the dip is N. 15° W. $<$ 15°, which is about the direction of the adit or slop upon the seam, which, according to Mr. Joseph Richardson, who was i charge of the prospecting here, was but two inches in thickness at the out crop, increasing in forty-five feet to three and a-half feet of very gooc coal. To the dip of this slope, in a position not now accurately known, bore was put down upon this seam, which Mr. Haliburton informs me provec its thickness to be six feet, the coal being of very good quality. This sean at the Culton adit, as the slope was called, was directly overlaid by a thir band of highly carbonaceous black shale, known as *oil bat* by the miners and then by a band, about six inches in thickness, of black carbonaceou shale, full of *Spirorbis* and *Cythere* shells. In the remains from the slope numerous fossils were found, among which may be mentioned well preservec teeth, spines and scales of *Diplodus*, with *Cordaites borassifolia* and impressions of *Lepidodendron*, *Antholites* and *Cardiocarpus*, not specifically determined.

Equivalence of Culton seam.

A large number of pits and bore-holes have been sunk in the great mass of black carbonaceous and argillaceous shales which overlie this seam by Messrs. Sinclair and Haliburton and the Intercolonial Coal Company, but no seam of coal has been found. This, together with the fact that it is shewn by the general structure to be in all probability the Acadia seam presently to be described, which again I believe to represent the Main, leads me to the supposition that the Culton seam is the representative of the Main seam of the Albion mines, its small size being partly due to the presence of a fault known to exist in the Culton adit, though there may also be a thinning of the seam in this direction.

One underlying seam is said to have been proved, but of its size, char-

er or position no record has been kept, though I am informed by a work-n employed in sinking the bore in which it was found that twelve feet of l were passed through. Still lower seams may crop out in the interval ween this bed and the South fault, but no exposures of coal are seen, l the drift being exceptionally deep (its thickness occasionally reaching m eighty to 120 feet) but few attempts have been made to find them, h trials as have been made always resulting in failure. Twelve feet seam.

The Culton seam is traced but a few yards to the westward of the Cul- adit, but the general structure would lead us to expect that at about rty-four chains N. 72° W. its crop would come against the West fault; this position a pit was sunk by Messrs. Bürkner and Ellershausen, en prospecting in this region, and two feet of a seam were found in the tical measures of a dislocation which was undoubtedly the West fault. West fault.

In passing round the west end of the Bear-creek synclinal the out-crops these seams do not leave the West fault until, at about thirty-six chains the bearing N. 33° W. from Messrs. Bürkner and Ellershausen's pit, arge seam of coal is found in trial-pits sunk by Mr. W. Barnes for the ercolonial Coal Company, which is known locally as the Acadia seam, l which is in all probability the representative of that of the Culton adit. e out-crop of this seam leaves the West fault with a general dip of S. ° E. about 400 yards south of the slopes at the Drummond colliery, and rves gradually north and to the west of north on the anticlinal between Bear-creek and Albion troughs, till the southern line of the Acadia mpany's Carmichael area is reached. Thus far its crop has been accur-ly ascertained by crop trial-pits and the underground workings from the ummond colliery. At this colliery the dip is E. (or S. 67° E. Magnetic) 16° at the surface, the dip at the north line of the area being about N. E. d the strike N. 41° W. (N. 18° W., Magnetic) is preserved across the rmichael (Acadia) area with great regularity as proved by the under-ound levels from the Acadia (west) colliery, where the dip is N. 49° E. 20° near the surface. Thence it is traced by pits to the Nova Scotia al Company's slope were the dip is N. 42° E <28°. Here the strike ns more to the west for eighteen chains, which is the distance that it has en accurately traced. A short distance farther this strike will intersect West fault, and the seam will be again concealed. This seam of coal about eighteen feet in thickness at the Intercolonial, Acadia and Nova otia collieries.* Drummond colliery. Acadia colliery. Nova Scotia colliery.

As has already been stated it would seem most probable that this seam the representative of the Main seam of the Albion mines, somewhat duced in thickness and changed in character, but still furnishing an Seam equivalent to Main seam.

* Sections of this seam at different points will be found included in the descriptions of collieries.

excellent quality of coal. Opinions have differed very much as to whic of the lower seams it should be identified with, many miners advocatin identification with the Deep or the McGregor seam. Many reasons exist f supposing it to be the Main, and I consider that the following facts wi remove all doubts on this subject:

By reference to Section 4 it will be seen that the greatest mass of barre measures between the Main and McGregor seams consists of the stra between the Main and Deep seams, amounting to rather more than 14 feet, while above the Main seam barren measures exist amounting to ov 1100 feet. Numerous trial-pits have been sunk on the measures overlyin the Acadia seam, in which no trace of coal has been found to my knowledg and a bore-hole has been sunk to the Acadia seam about fifteen chai from the Drummond colliery in a bearing S. 67° E. by Mr. Barnes, whic according to his record, proved barren black shale directly overlying th seam to a thickness of about 170 feet at right angles to the plane of the strat These shales as seen in the Drummond colliery air-pit are remarkably lik the black carbonaceous shale from the Foord pit at the Albion mines. Th six inches of shale immediately overlying the seam at the Drummon colliery contains, *Spirorbis* and *Cythere* shells, *Antholites*, *Lepidodendro* *Cordaites borassifolia*, and markings which I am informed by Dr. J. W Dawson are *Lepidostrobus*.

Barren measures over Acadia seam.

Fossils.

At the Acadia colliery no records exist for an accurate section of th strata. A short section as furnished by the record of the air-pit is give in the description of the colliery, and above this the measures obtained i the railway cuttings and in a number of pits sunk on Red Brook runnin north-east from the colliery appear to consist of black argillaceous shale with some thin bands of bluish-grey argillaceous and white arenaceou shales having black carbonaceous partings, the white shales bein in beds of from one twentieth to one fortieth of an inch in thicknes Farther west the measures directly overlying the Nova Scotia Coal Com pany's slope appear to be very thin bedded black arenaceous shales, wit bands of carbonaceous and argillaceous black shale.

Red Brook.

A second seam has been found underlying the Acadia seam at abou 160 feet, which probably represents the Deep seam of the Albion mines also a third which I believe to represent the Third seam of the Albio group. A fourth is reported, but of this no record can be obtained.

Seam equivalent to Deep seam.

The crops of the Second and Third seams run nearly parallel with tha of the Acadia seam. The Second has been proved on the areas of the thre companies working the Acadia seam, and is said to be about twelve feet i thickness, of which eight feet are reported to be good coal. The coal from this seam which I have examined, however, is coarse and shaly with about 30 per cent. of ash; but the specimens not having been taken from the

am by myself, I cannot state that they fairly represent the entire nch of eight feet. The crop of the Third seam, being quite near the est fault, will probably be confined to a short run on the Intercolonial id Acadia (Carmichael) areas.

West fault.

Continuing the course of the West fault north-westward we find no fur-er appearances of the lower coal seams along the western boundary of the al field, the structure indicating the deepening of the coal measure ough, and that the higher rocks are brought against the Millstone Grit ries on the west side of the West fault until we approach the North fault. ie position of the intersection of these dislocations is approximately shown the map, but farther explorations may induce alterations.

North fault.

The boundary of the coal field now becomes the North fault; and tracing is east, we find the altered Devonian rocks brought against barren coal easures, probably representing the black shales, with no appearance of e lower seams until the Sutherland and the Montreal and Pictou areas are ached, when the outcrops of at least a portion of the lower group of coal ams leave the fault in a north and south transverse swell on the north se of the Albion synclinal, the curve of these crops corresponding in some egree with the opposite curve in the crops of the Albion group of seams the south rise of the trough.

Montreal and Pictou area.

Before reaching the East River the out-crops turn back towards the fault, id meeting it at nearly a right angle, are not again seen in the region camined. The small extent of surface over which these seams can be oserved, the almost entire absence of exposures,and the change in the char-cter of both seams and including measures, combined with the igh angles of dip and sharp turns in the strata, as seen on ie banks of the East River, render the identification of coal seams here ith those of Section 4 at the Albion mines, a matter of extreme difficulty. The region for some distance from the great North fault is also much isturbed by minor dislocations, and none of the coal seams have been suffi-iently opened to show their characters when in an undisturbed position.

Difficulties of comparison.

At present the only obtainable facts with regard to the seams at this oint are in the records of the Montreal and Pictou Coal Company's trial nd working-pits, a record of borings made for the Intercolonial Coal Com-any on the Sutherland area, and such verbal information as Mr. Halibur-on, managing director of the Montreal and Pictou Company, has been able o give me concerning the underground work done by that company. The xposures on the banks of the East River give the structure of the eastern ide of the tranverse elevation; the Montreal and Pictou pit gives the south ide and turn of the strata to a strike a little south of west; but for the vestern dip, we have only the records of two trial-pits, and such facts as he topography and surface rocks can furnish.

Evidences.

Seam equivalent to McGregor seam.

It has been supposed that the seam proved in the working-pit of th Montreal and Pictou Company represents the Main seam of the Albio mines; but the fact that coal crops are connected with mea sures manifestly overlying this seam a few hundred feet, together wit the fact that the seam appears to be within 225 feet of another proved o the old road to Fraser Ogg's quarry, which for reasons to be given here after, I am inclined to believe represents the Stellar seam of the Acadi mines (Fraser area), leads me to identify the Montreal and Pictou sea with the McGregor, rather than with the Main or Deep seam, the equiva lents of which, in absence of evidence to the contrary, I am inclined to thin will be found to overlie it. The following facts may lead to the finding o one or both of these overlying seams. I would first remark, however, tha in a region so likely to be broken by faults, mistakes in distances betwee seams are to be guarded against, as different exposures of the same sean when it is thrown by faults, may be mistaken for different seams.

Nine-feet coal seam.

(1). On the south-eastern portion of the Intercolonial Coal Company' Sutherland area, a bore-hole was sunk which passed vertically throug twenty feet of coal divided into two parts by four and a-half feet of fir clay. The inclination of the strata is not stated, but it is supposed to b about 65°, which would give a thickness of about nine feet to the coal an a foot and a-half to the parting. The position of this would appear to plac the seam higher stratigraphically than that of the Montreal and Pictou pi

Seam equivalent to Main seam.

(2). On the west bank of the East River, near its intersection with th north line of the General Mining Association's area, there is a mass o coaly shale of considerable thickness, mixed with a black shale so highl carbonaceous as to yield a large amount of gas. It is supported by *Stigmaria* underclay, beneath which occurs the crop of what appears to be true coal seam. This, it appears to me, may possibly represent the Main sean

Seven-feet seam

(3). On the same bank of the river, opposite the town of New Glasgov a pit was sunk on a coal seam stated to be seven feet thick; this, it said, was lost upon a fault, and as no record of the work was kept, its exac position cannot be given. At the time this was opened it was suppose to represent the Montreal and Pictou seam, but from the structure, whic is well shewn on the river bank, I am inclined to think it belongs to measure several hundred feet higher.

Albion group of seams, in relation to the North fault.

Provisionally considering the Montreal and Pictou seam as the McGre gor, it would seem probable that the crops of the Albion group leave th North fault, with westerly dips at a moderately high angle, at some dis tance west of the east line of the Sutherland area, and the seam provision ally considered to be the Oil coal will be not far from this line at the faul

This westerly dip is preserved by the upper portion of these seams ti they approach the Montreal and Pictou corner on the General Minin

sociation's north line, near which a pit (No. 2 of the Intercolonial mpany's Sutherland area record) has proved the dip to be S. 67° W. (or magnetic) in bearing, with an inclination of about 65°. The Montreal l Pictou seam at the working pit, dips S. 43° E. (or S. 20° E. mag.) 65° ; there must therefore be a very abrupt turn or a dislocation ween the two pits. At the working pit the seam thus shows a n toward the northeast, and thence the structure can be given h comparative accuracy from the river exposures. These show run of the measures to be nearly parallel with the bank of the stream, nding somewhat to the east of north until opposite the town of New asgow, where they all come against the North fault again, with a strike bably at about right angles to its course.

In a region so likely to be disturbed by the forces which have produced lislocation of such great extent as the North fault, records of scattered s are always unsatisfactory, as the dip in any of these pits may be luenced by a fault, or by a sudden twist in the strata, even if a break has t occurred. The structure of this immediate part of the coal field, as licated on the map, must therefore be understood as merely general and istrative, and liable to considerable alteration in detail from future explorans.

Provisional structure.

Few researches for coal above the black shales.

The presence of the great seams of the Albion group has prevented y attempts at systematic explorations for coal beds above the barren ick shales on the west side of the river. A few trial-pits, however, ist in the upper portion of these measures, but of these there is in most ses no record, and the only indications of coal there at present known e believed to belong to a bed which occurs between the black shales overng the Main seam of Section 4, and certain black shales of Potter's rook on the east side of the East River ; the only evidences of this seam e in the pits mentioned, and a few exposures far apart from one another. is I have called the Three and a-half feet seam.

Three and a half feet seam.

Distribution.

McCulloch-brook fault.

The seam is first seen in a cutting on the Nova Scotia Railway, about o chains north of the culvert over Coal Brook in the vertical measures a fault ; but it is here on the south rise of the Albion synclinal, and its op is known westward about one mile by two pits, one sunk on the side the New Glasgow and Hopewell road, near the crossing of Coal Brook, d the other on a small branch of the same brook, about one half mile est. Thence the general structure would indicate that its course would be mewhat as shown on the accompanying map, where it is represented at at the McCulloch-brook fault the crop is thrown about seventy chains uth. This seam does not appear in the Bear-creek synclinal, the deepest int in this trough showing only about 800 or 900 feet from the surface the Acadia (Main) seam. West from the McCulloch-brook fault the

Axis of Albion synclinal.

crop turns north-west on the south rise of the Albion synclinal, crossir the old post road to Middle River a short distance west of the Intercoloni Coal Company's railway. Thence it is not known except by a crop on tl post road to Truro, near the turning to the private road running south to tl Horn farm. This point is shown by the structure of the measures below tl seam to be nearly on the axis of the Albion synclinal, and the seam pr bably crosses the road nearly at right angles to its general course.

Coal crop on McCulloch's Brook.

An E. and W. fault.

Beyond this exposure the course of the crop cannot be followed wi accuracy back to the McCulloch-brook fault, and as laid down c the map it must be taken as conjectural, and as merely illustrative of tl general structure. The only coal crop known on the north rise of the Albic synclinal between the West and McCulloch-brook faults was met with in la ing the foundations for the Intercolonial Coal Company's railway bridge ove McCulloch's Brook. This is stated to have a thickness of thre feet, and it is probably the seam in question, though it is here carried eas ward, and nearer to the centre of the synclinal than might have bee expected, by the effect of an east and west fault presently to be describec throwing up the measures on the north side. From this position at the railwa bridge the general structure would bring the crop to the McCulloc brook fault, but this being an upthrow on the east side, the plane of tl seam is carried by it above the general level of the surface, and the cro does not again appear on the north side of the east and west fault, unless it b represented on the north branch of Coal Brook, which is a considerabl distance to the east, by a coal crop a few feet on the north side c the disturbance above alluded to, which it leaves for a few chains, returnin to it again.

Coal crop near Coal Brook.

Farther eastward the north rise of this seam appears to leave the sout side of the fault, and on approaching the Albion mines there are indicatior of its crop on the north side of the Hopewell road about two chains north c the railway bridge near Coal Brook; this, and a similar exposure c the East River at the mouth of the brook, seems to show the general cours of the Three and a-half feet seam as far eastward as it is at preser known. No other coal seam overlying the black shales has been observe to the west of the East River.

Systems of faults.

All the greater faults limiting or considerably effecting the distr bution of the coal seams, have already been alluded to. Thos affecting the underground workings in the different collieries will b mentioned farther on in the detailed descriptions of these workings but besides these many dislocations of greater or less extent travers the Productive coal measures, though the greater number of ther are of slight importance. These may be divided into three series, thos belonging to each preserving a general parallelism in their bearing

ugh a few exceptions are known. They are (A) faults having a gen-l course of N. 33° W. and S. 33° E.; (B) faults having a general aring E. and W.; and (C) faults having a direction of about N. 67° E. l S. 67° W.; besides these a fourth series (D) may be added having a urse of N. 58° W. and S. 58° E., of which several examples have been own, as will be especially seen in the workings of the Deep seam at the bion mines.

Of these minor dislocations two have been observed affecting the asures near the centre of the Albion synclinal, of which descriptions y be introduced here. The first, which may be called the Potter's-ook fault, was first noticed on that brook near its junction with the East ver. It is a downthrow to the south, apparently of considerable extent, d has an E. and W. direction, the exact bearing from Potter's Brook stward being N. 86° W. It has been traced westward from the East ver about a mile and three quarters, and is the same break as has ready been mentioned in connection with the Three-and-a-half feet coal am. My belief is that it will extend across the McCulloch-brook fault, which it would seem to be broken and thrown southward, and thence ll be found to run across the western portion of the coal field to a point ar the intersection of the North and West faults. This supposition has en induced by the fact already stated, that a fault with a southern down-row seems to affect the crop of the Three-and-a-half feet seam between e Truro post road and the railway bridge on McCulloch's Brook. The otter's-brook disturbance would thus belong to a more ancient system of ults than that deriving its name from McCulloch's Brook. Potter's-brook fault. Broken by the McCulloch-brook fault.

The effect of the second of these dislocations is seen at the railway on bridge over the East River, just above the town of New Glasgow, here the measures, which, on the right bank of the river above the idge, are seen with dips somewhat to the south of east at moderate gles, on approaching the fault are suddenly thrown round to a dip of orth at a high angle. This turn to the north at this point is probably in art due to an undulation corresponding to a third or subordinate syncli-al, which you have observed on the east side of the river, and which, I elieve, you have named the North synclinal. But the immediate cause f the sudden turn and high angle of dip in the strata appears to be due the fault, which has a bearing N. 67° E. at the lower end of the bridge. Bridge fault.

ECONOMIC CONSIDERATIONS.

In the treatment of this coal field with reference to its economic impor-ance, it would seem best to divide it up into the different mining areas as urveyed and leased by the Mines Department of the Province, giving Economics.

under the heading of each area, descriptions of such collieries as are now active operation, of workings which have been abandoned, and of railwa built and owned by the various coal companies.

Extension of map.

It has therefore been thought proper to extend the map designed illustrate the region, beyond the area examined, in order to show the co nection of the Productive coal field with tide water at Pictou and Merig mish harbours ; and with a view of properly filling the topography, a numb of roads near the town of Pictou, and a plan of that town, have been take from a map of the county of Pictou published by Messrs. A. F. Churc and Co. of Halifax.

The southern limit of the map will be the parallel 45°.30′ of north lat tude, while northward it will extend as far as the entrance of Picto harbour on the Gulf of St. Lawrence ; east and west it will reach so fa as to include the harbour of Merigomish and the valley of the West Rive

The projection of the map is based upon Admiral Bayfield's determ nation of the geographical position of Pictou light-house at the entrance o Pictou Harbour,* and Betty Point, Merigomish Harbour †.

GENERAL MINING ASSOCIATION.

General Mining Association.

The history of the acquisition by the General Mining Association of th Royal patent granted to the late Duke of York, giving them possession o all the minerals of the Province of Nova Scotia ; of their extended workin and exploration in Pictou and Cumberland counties and the island of Cap Breton, and of their final cession of the greater portion of their rights in consideration of certain facilities and franchises granted them by the Pro vincial Government, is too well known to need rehearsal.

ALBION MINES AREA.

Albion mines area.

By reference to the map it will be seen that the area of three square miles, selected by this association in the coal field, is the central one of the areas embracing the Productive coal measures. It includes the crops of the two principal seams, the Main and the Deep, both of which have long been worked by the company. Till within a limited period the Albion mines, and some workings on the McGregor seam on what is now called the Fraser area of the Acadia Coal Company, constituted the only regular workings of the Pictou coal field, and upon the coal shipped by this company was established, in the first instance, the reputation of Pictou coal.

Importance of the workings.

These workings have now reached a great importance, not only from their considerable extent, but from the number of collieries in active opera-

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* Pictou light is in 45° 41′ 25″ north lat., and 62° 39′ 19″ west long.

† Betty Point is in 45° 38′ 29″ north lat., and 62° 26′ 40″ west long.

n. and from an actual power of production exceeded by very few on this ntinent. Although these collieries are included under the general term the Albion mines, it will be necessary to describe them under the follow- g local names, indicating either districts with well marked boundaries or parate working pits: 1, Burnt mines; 2, Crushed mines (abandoned); Dalhousie pit works; 4, Forster pit works; 5, Foord pit works, all on the ain seam; and 6, Cage-pit works on the Deep or Cage-pit seam.

Burnt mines.—The Burnt mines include the earliest workings from the op of the Main seam, and extend from the west bank of the East River out one-half mile northwest toward the Dalhousie pits. Although these rkings have long been abandoned in consequence of a fire, I am ormed that the pillars have not been crushed, and might still be taken t, should the course of trade require it. Burnt mines.

Crushed mines.—The Crushed mines are situated to the deep of those st described, their extent being from the east bank of the East River rthwest to the Dalhousie pits, a powerful barrier of coal being left tween them and the Burnt mines. Crushed mines

Dalhousie pit works.—The Dalhousie pit works are at present in actual eration and capable of producing about 800 tons of coal per diem. The achinery at the Dalhousie Bye pit, or drawing pit, consists of one 50 rse-power beam engine, single cylinder, drawing cages containing one x or car holding 1500 lbs. of round coal, by a 4-inch flat wire rope. Dalhousie pit works.

The arrangements at bank, shutes and railway near the pit head are of very complete, substantial and convenient description, and the celerity of isting, dumping and screening the coal at the pit head evinces a system d management worthy of imitation elsewhere. This pit has been exten- vely worked during the past summer, the coal raised being taken princi- lly from the pillars.

Forster pit works.—The Forster pit is a late working of this company, d during last season was only irregularly in operation. When in full eration it will be capable of producing from about 500 to 700 tons coal per diem. The arrangements at the pit head and elsewhere are ich the same as those at the Dalhousie pits. The workings of the Fors- r pit, Dalhousie pit and Crushed mines are pumped from the Engine and aple pits at the Crushed mines, communication being made for this pur- se. The water is lifted by a large double-acting Cornish pumping gine of about 100 horse-power driving the top lift of the pumps in the aple pit, and the bottom lift in the main or Engine pit, the lifts being out 250 feet each. Forster pit works.

Foord pit works.—The Foord pit works, when in full operation, will be of great importance to the coal field that I may be excused for giving e full description which follows of the pits and machinery in so far as Foord pit works.

complete at the time of my return from field work. In size and in th
perfection of design in the machinery, and in fact of the entire plan
these works will compare most favourably with any on this Continen
and may be considered an important addition to the wealth of th
Dominion.

Two principal pits.

Two principal pits, known respectively as the Foord drawing and pum
ing pits, have been sunk to the Main seam at a horizontal distance of 96
yards from the crop, reaching a depth of 878 feet; and a third to a dep
of 330 feet for the first or top lift of the pumps, the drawing pit being abo
40 yards to the deep of the other two.

Drawing engines.

The drawing engines are two high-pressure horizontal cylinders 3
inches in diameter and 5 feet stroke, or as connected, of about 160 nom
nal English horse-power. The crank-shaft connecting these engines is 1
inches in diameter and carries a 20-feet drum, included between two 2
feet fly-wheels, which are fitted with powerful friction brakes, by means
which the engines can be stopped almost instantly, should circumstanc
require. The engines are fitted with slide-valves, moving on anti-frictio
rollers, and the arrangement of weigh-bars for the throttle, links and brak
is such that one engineer has them under perfect control. The cages in th
pits are made of bar steel, weigh about 900 lbs. apiece, and are doub
decked, carrying four cars or boxes holding 1500 lbs. round coal each. Wi
the moderate piston speed of 250 feet per minute, and allowing full tim
for all ordinary delays and stoppages, these engines ought easily to deliv
1000 tons of coal on the platform, per day of ten hours, which, with co
from the banks, would make the ordinary production in full operation abo
1500 or 1600 tons of coal per diem.

Engine house.

The engine house (61 by 35 feet) and all fittings in the pits and arou
the pit head are of the most substantial character, the engine house bein
of cut stone and brick, the foundations of cut stone and concrete, the pilla
for the platform of brick, and the timber work of frames, platform and pi
timbering, of the best southern pine, a ship load of which was especial
selected for these works.

Pumping engine.

The pumping engine is a single cylinder, high-pressure Cornish engin
the cylinder being 62 inches in diameter and of 9 feet stroke, or 240 nom
nal English horse-power. This engine is set upon a massive column of c
stone, resting on the solid rock below. The height of this pillar is as fo
lows:—From the foundation (at the surface of the ground) to the top
cylinder pillar 21 feet 6½ inches; thence to the top of the beam pillar 2
feet; and from the top of the beam pillar to the centre of the bearings
feet 6 inches; or about 50 feet from the surface of the ground to the bearing

The cylinder is set over the top-lift pit, the piston-rod, 8 inches
diameter, coming through the cylinder bottom, driving the top set of pum

ct, as in the Bull engine, the second and third sets being driven through beam, which is of wrought iron plates riveted to iron castings. This beam 4 feet long, 7 feet deep in the middle and 2 feet 4 inches at the ends, veight being 18 tons, without gudgeons, these being of wrought iron 14 nes in diameter for the central one at the bearings, increasing to 16 inches he middle, the end gudgeons being 8 inches in diameter, increasing to inches in the middle, and the intermediate for parallel motion rods being inches in diameter.

The pumps, etc., are of the following patterns and sizes : Pumps.

First or top set lifting pumps, working-barrel, 18 inches diameter.
Second or middle forcing pumps, working-barrel, 18 inches diameter.
Third or bottom set lifting pumps, working-barrel, 18 inches diameter.
Column pipe, inside diameter, 19 inches.

Both drawing and pumping engines are supplied with steam by a suite of cylindrical boilers, high pressure, 5½ feet in diameter and 35 feet Boilers. g, fed with water by two donkey engines and pumps of 7-inch steam linder, and fitted with the latest appliances for convenience and fety. Flues, furnaces and stacks, are substantially built and lined with e-brick.

The General Mining Association own a fine railway, six miles long, from Railway. e Crushed mines to the loading ground, with branch lines, sidings and ssings amounting probably to four miles additional. The loading wharf Wharf. situated on Pictou Harbour, at the mouth of the East River, and extends 0 yards from the shore to 22 feet of water.

Vessels of greater draught than 20 feet are generally loaded with coal om lighters owned by the Company, who also keep a powerful tug in the rbour for the convenience of vessels consigned to them. The arrangeents at the wharf and the amount of rolling-stock, including five locomoves, appear to be ample for a shipment of about 3000 tons per diem. he largest amount thus far regularly shipped was during the summer of 367, when shipments averaged for some weeks 2,400 tons per diem.

The locomotive, car, and blacksmiths' shops are well stocked and arranged, Work shops. nd at the machine shop and foundry all small machinery, and even some ope engines of considerable size, (24 inch cylinder), and of very creditable orkmanship have been manufactured. In addition to the works described, e Association have built a large number of houses for overmen, workmen nd others, and have a full complement of repair and carpenters' shops, arns and other buildings, all upon the property area of the company.

UNDER-GROUND WORKINGS MAIN SEAM.

The first pits at the Albion mines known as the Stair, Store, Engine and Burnt-mines pits. 3ye pits, gave access to the workings of the Burnt mines, which extended

on the lower level about 250 yards southeast, and 900 yards northwe toward the Dalhousie pits, the deepest pit being the Engine or drawing p 199 feet to the bottom of the Main seam. These pits are now entire crushed in and filled with *débris*. Separated from these workings by barrier of about thirty yards of coal are the Crushed mines, which we worked from the following pits :

Crushed-mines pits.

Engine pit for pumping	451 ft.	6 in.	to Main seam.
Bye or No. 1 pit for drawing	436 "	6 "	" " "
No. 2 pit	392 "	0 "	" " "
No. 3 pit	332 "	0 "	" " "
No. 4 pit	284 "	0 "	" " "
Up-cast pit	248 "	0 "	" " "

Pits Nos. 1, 2, 3 and 4 correspond to the four railway bords or ma levels, in former times a pit being sunk for every six working bords.

The lowest level of the Crushed mines extends about 1000 yards sout east from the Bye pit, or about 180 yards beyond the meeting of the thr roads near the Big branch bridge, East River ; and from this level at 60 yards from the pit a slope was sunk, running eastward at *half across di* or at an angle of 10°, and from this slope, workings were in successf operation until the fire occurred which caused the Crushed mines to b abandoned. Westwardly the lower level extends about 1200 yards to th barrier of the Dalhousie pit workings, and at about 100 yards from the p a slope has been driven about N. 48° W. 700 yards.

Foord pits.

Fears have been entertained by the workmen employed in the Foor pits that danger might exist of *holing into* these old workings, now fu of water ; but according to careful plans, as kept in the office, no point these deep workings approaches nearer than about 400 yards, or nearly quarter of a mile, to the Foord pits.

Dalhousie pits.

The Dalhousie pits are four in number : 1, Dalhousie Bye pit 250 fee deep ; 2, Engine pit of the same depth ; 3, Top pit 130 feet deep to th Main seam ; and Dalhousie Down-cast pit 440 feet deep through the Mai to the Deep seam.

Dalhousie section of Main seam.

The section of the Main seam at the Dalhousie pits is as follows, reduce from the records of the Engine pit :

	Ft. I
Coarse coal	0
Good coal	4
Iron stone	0
Good coal	13
Iron stone	0
Coarse coal, of good quality	7
Iron stone	0
Coarse coal	2
Iron stone	0

	Ft.	In.
Coarse coal	2	7
Iron stone	0	5
Coarse coal	4	5
	36	9

To the east of the Dalhousie pits the upper twelve or fourteen feet only he seam was worked, the bottom coal not being considered marketable. the north-west, however, the whole seam is worked in the Dalhousie kings, giving some twenty-eight feet of excellent coal, the bottom being rser merely in appearance. The six-inch parting of ironstone reases going west and encroaches on the *fall coal*, which is not worked the Forster pit. Farther west, at the western face of the Forster pit rkings, the whole seam appears to deteriorate somewhat, the coal becom- of a dull lustre and shaly texture, and several of the partings increasing thickness. About twenty-two feet of the lower part of the seam is there rked.

The lower levels of the Dalhousie pit extend 1,100 yards north-west the Forster pit, dip workings having also been extensively wrought from lope, the head of which is near the Dalhousie Engine pit, through ich steam is supplied to the slope engines. These engines, and also se of the two Crushed mines slopes, are horizontal drawing engines, h connected 24-inch cylinders and 48-inch stroke. They hoisted coal ins of twelve boxes each. The bearings and distances to which this slope s driven are N. 48° W. 920 yards, then, the dip increasing, N. 66° W. 0 yards farther. Lower levels.

From the Forster pit the lower railway bord or main level has been rried 480 yards west, giving an entire length of working of 3,600 yards m the eastern face of the Crushed mines. On account of the deteriora- n of the seam going west very little coal has yet been taken from the stern workings of the lower levels; a slope 150 yards to the dip and a velling way driven to the crop constitute their extent. Forster pit.

The Foord pit workings under ground consist of the three pits already scribed and a small amount of narrow work, the levels extending at esent about 100 yards north-east and south-west from the pit bottom. e progress of the workings has lately been delayed by an explosion of s, which, but for previous precautions and promptness of action, might ve proved disastrous. Fortunately however, the men were got out without ury, the loss being that of the horses under ground and the burning of portion of the timbering and guides of pits. The damage having now been paired, work will be resumed at once. At the time the explosion occurred larch 27th, 1869) eighty four men were employed under ground. Explosion Foord pit.

Under-ground workings Deep seam.

Deep seam.

The Deep seam workings are reached by Cage (drawing) and Succe (pumping) pits. The capacity of these works is similar to that of t Dalhousie pits, and the over-ground works are of the same design and exter with the exception of the pumping machinery, consisting of a large ho zontal engine driving two lifting pumps.

Cage pit.

Levels have been driven about 2,300 yards west of the Cage pit, a for about one mile of this distance the coal above the bottom level, abc 250 yards from the crop, is standing in pillars, with the exception o portion 1500 yards from the pit, where pillar working has been co menced. Eastwardly from the pit the workings have been carried or about 170 yards, where gas becomes so troublesome that work was stoppe

Deep seam section.

The section of the Deep seam, near the eastern face, is nearly follows:—

		Ft.
Dark brown carbonaceous fireclay		4
Dark brown carbonaceous shale	worked	0
Good coal	worked	2
Coarse coal	worked	0
Good coal	worked	2
Coarse coal	worked	1
Good coal	worked	5
Shale or shaly coal, not exposed	worked	3
		20

Cage pit section.

Going westward the character of the coal materially improves. At thi quarters of a mile from the Cage pit the section is:

	Ft.
Good coal	6
Very coarse coal holding much iron pyrites, called stone parting	1
Good coal	11
	19

Here the seam is at its best, and was all worked, yielding, with exception of the coarse coal parting, most excellent coal. From the fou counterbalance to the western face, the bottom bench, ten feet of good c is worked; the upper portion of the seam has not been proved lately.

Systems of working at the Albion mines.

System of working.

With slight modifications *the post and stall*, or *pillar and bord* systen working has been used in the Albion mines since the first openings w

Pillar and bord.

made. The practice of this system involves long bords, or working plac and gate roads or inclines, running diagonally across the bords to the m level, at such an angle to the full dip, that the coal can be easily taker

railway bord by sleds drawn upon the floor of the seam; by cars nning on railway tracks, drawn up to the bords by horses, and withheld m too great a velocity in descending by a drag chain running around a ut post at the head of the incline; or by cars running on a three-rail ck, with passings, a drum with a friction brake being so arranged at the ad of the incline that the loaded cars in descending draw up the empty ones. e bords are in most cases about 6 yards wide, the pillars from 8 to 12 rds.

During the past two years the new back-balance or self-acting counter- Back-balance. lance system has been introduced at these mines, and is now in success- operation in the Cage-pit workings. This was first used in Lancashire, gland, and was introduced into this province by Mr. Hudson of the neral Mining Association.

In this system an incline about 10 feet wide is started from the main vel, and driven direct to the rise, either to the next level, or above the per level, as far as it is intended to work the coal. Two tracks are laid in e back-balance, extending from the the main level to within about 20 feet of e top of the incline, where a drum fitted with a friction-brake is firmly set. pon one of the tracks (say the left for illustration) runs a car or box so aded with stone as to rather more than counterbalance the weight of a ge running on the right track when loaded with the weight of an empty r (supposing them to be connected by a wire rope or chain, passing und the drum at the head of the incline) while the weight of a full car the cage will cause it to descend, raising the weight of the car loaded ith stone.

In getting the coal a barrier is left for the main level, and then the first orking bord is turned from the back-balance (to the right) and continued the strike toward the next counterbalance, a distance varying from 150 200 yards. Farther to the rise working bords are turned off at regular tervals, the system in the Cage-pit working being, main barrier 21 feet, ords 18 feet, pillars 18 feet. The platform of the back-balance cage ns down to a level with the floor of the main level, and a section of track laid upon it (as in a pit cage) which is continous (when the cage is in osition), with the rise track of the level. An empty car now being run to this cage, and the brake of the drum being slackened, it is evident that e car will be drawn up the incline by the counterbalance weight, and that can be stopped by the brake opposite to any of the bords where it may e required.

A temporary track being kept to the working face of all the bords, the ar is run into the bord, filled, and again run into the cage, when its increased eight causes it to descend, the speed being regulated by the brake. On its rrival at the main level, it is pushed from the cage by an empty car, which

Economy of the system.

in its turn goes through the same process. As an example of the expeditic and economy of this system, I may mention that one boy, at $0.60, ca at the Albion mines brake down from 275 to 300 boxes of coal, holding 150 lbs. of coal each, per day of ten hours.

Fire damp.

In the working of both the Main and Deep seams fire-damp or ligl carburetted hydrogen gas is sometimes given off the coal, in quantitie which not only prove troublesome in requiring safety-lamps and other pr cautions, but also sometimes cause explosions disastrous to life and propert in spite of all precautionary measures. Several serious explosions hav occurred in the older workings, in which not only have men been serious injured, but the coal in the seams has been ignited, threatening the enti workings with destruction. In fact, so alarming did one fire from this caus become that it was deemed necessary to turn the water from the Ea River into the workings (the present Crushed mines) as the only possib means of extinguishing the flames. The greatest care is taken to preven these disasters, to which all the mines of this region are liable, stringe rules being provided with regard to the use of the lamps; and by order the Inspector of Mines, danger signals are posted, beyond which ope lamps cannot be taken.

Precautions at the Albion mines.

At the Albion mines the greatest precaution is observed; barrels of wate being kept in every working bord, and several small cannon are kept co stantly loaded when gas is feared, to extinguish it if possible by concussio of the air. With all this care a blower of gas will sometimes ignite, gen rally from a blast, and become troublesome. Into the crack from whic one of these blowers appeared, an inch copper tube was driven, and the ga ignited, when a flame was produced two feet long, which burnt continuous for six weeks. Against these explosions the only safeguards appear to b the most perfect ventilation, and cutting instead of blasting the coal.

Difficulties of working great seams.

The working of seams of coal of the size of the Main and Deep is at bes a very difficult problem, requiring great care and experience. The explo sions, fires and inundations to which the greater portion of the Crushe mines workings have been subjected have proved the immediate causes o the *crushes* extending over these workings, and also over a portion of th workings of the Dalhousie pits, resulting in the loss of several of th Crushed-mines pits, and a large amount of pillar coal. The original caus

Inadequate pillarage.

of these crushes, however, has been from an inadequate scale of pillarag the large size and considerable angle of the seams requiring pillars of a extent proportionally much greater than those required in most of the En lish coal fields, where, as a rule, the seams are of moderate size and th angle of dip quite low.

Faults.

Very few faults have been struck in the workings of the Albion mine Three were met in the Crushed mines dip-workings of the east slope. Th

has a course of N. 21° W, being a downthrow east of 40 feet at the slopes and running out to 3 feet at the lower level of Engine pit. The nd is still farther, being at the end of the slope; its course is N. 10° W.; a downthrow eastward of 14 feet. The third is one connecting the and second and not cutting the first; its course is S. 73° E.; it is a nthrow to the northeast of about 50 feet, where proved at about half ance between the first and second faults. Near these faults the gas struck which caused the fire in the Crushed mines. Besides these three w small faults are found in the workings of both seams, which appear to arranged in two systems, the one running N. 33° W., the other 8° E., which, it will be observed, are the courses of several of the import- dislocations affecting the general distribution in the coal field. Gas near faults.

he parallelism of the cleats or joints of the coal, and also of numerous ll faults of a few inches throw, in the Deep seam, is quite noticeable ıgh by no means exceptional. With very few exceptions their course . 58° W., while in the Main seam no marked parallelism is observed, e running N. 67° E., others S. 88° E., N. 33° W. and N. 58° W. Cleats.

ACADIA COAL COMPANY OF NEW YORK, U. S.

he Acadia Coal Company own three mining rights, which are as fol- s: Acadia Coal Company.

he Fraser area, south of the General Mining Association's area; the michael area, southwest of the General Mining Association's area; and . 3 area, lying to the south of the Fraser area.

FRASER AREA.

Vorkings have been carried on for many years upon the Fraser area; t by the General Mining Association, and more lately by Mr. J. D. B. ıser, of Pictou, from whose possession it passed by lease to the pre- t company. Fraser area.

Attempts have been made by former owners to work the Deep seam on western portion of the area at the McKenzie pit, and a slope has also n driven some distance on the crop of the Third coal seam, both of ich workings are now abandoned, and therefore require no special scription. The present workings are confined to the McGregor seam l two openings on the Oil-coal. McKenzie pit. Deep and Third seams.

McGREGOR COLLIERY.

In the McGregor colliery the openings consist of No. 1, an adit, No 2, a pe, and No. 3 a pair of slopes. McGregor colliery.

Adit No. 1 was opened by the General Mining Association on the left nk of Coal Brook, near the crossing of the Middle River road, and driven No. 1 Adit.

N. W. a distance of about 800 yards. The seam was irregularly worl by the General Mining Association and Mr. Fraser, but is, I believe, for present abandoned.

No. 2 slope.

Slope No. 2 is a single slope to the lower level of No. 3 slopes, and formerly the working slope, but is now used only as a travelling way. stands on the left bank of Coal Brook near the mouth of No. 1. Slo

No. 3 slopes.

No. 3 are the principal working. Their situation is 170 yards S. E. No. 2, on the right bank of the brook. Their total depth is 510 feet. M levels extend 260 yards N. W. and but 20 yards in the contrary dir tion. The dimensions of the slopes are : Drawing slope (a double r way track) 9 feet post, 9 feet cap and 14 feet ground sill. The tra are all of T iron 25 lbs. to the yard. The second slope, a travelling way horses and men, is separated from the drawing slope by a 14 feet barrie coal; its height is the same as that of the drawing slope, with 6 feet and 8 feet ground sill. A temporary engine is of 14 nominal Eng horse-power, with a horizontal single cylinder, driving the hoisting drum shafting with clutch gearing; and also pumping through the Flem pump pit by a wire rope running over sheave pullies to the pump bob.

In working the McGregor seam the upper coal (included in the up six feet of the seam) is the only portion taken out, the lower bench be unsaleable. The seam is found to rapidly improve going west, as wil seen from the following sections :

Upper coal.

McGregor seam, upper coal.

	At No. 2 slope.		At western	
	Ft.	*In.*	*Ft.*	*In.*
Good coal	1	9	2	9
Arenaceous fire-clay parting	1	0	0	6
Good coal	3	0	4	0
	5	9	7	3

Near the western face, the bord and pillar system with incline roads has been commenced. Elsewhere in the working the back-bala system is used.

OIL-COAL WORKINGS.

Oil-coal.

Two slopes have been sunk upon the Oil-coal seam, namely the Fr mine on Coal Brook, near No. 3 slopes, and the Stellar mine on Mc loch's Brook. The principal value of this seam consists in the large quar of oil contained in the bench mentioned as oil-coal in the general sect which in former years was extensively worked, the oil coal or *stellarit* it has been named by Professor Henry How, who first described selling for a high price for gas-making and distillation. The pre low price of coal-oil from the extensive working of petroleum in country and the United States, combined with the high tariff on impo

imposed by the United States, have combined to render the work- of this seam unprofitable, and both workings are for the present aban- ed.

s the quality of this peculiar coal will receive especial attention in the endix to this report, I will merely state in conclusion that from the e content of oil this seam must at some time prove of considerable value. m pits sunk by the Acadia Coal Company it would appear that the size quality of the Oil-coal bench improves towards the east, the greatest kness (1 foot 10 inches) being procured in a pit sunk at the corner of ve-street and Pennsylvania avenue in Acadia village, which coal pro- ed 120 gallons of crude oil to the ton; the average obtained from the ser mine being about from 60 to 65 gallons per ton.

Carmichael area.

Carmichael area.

or many years no workable coal was known to exist to the west of the Culloch-brook fault, on which the Albion coal seams are lost; and ugh many attempts were made to ascertain the position of these seams coal was found until the 18th April, 1865, when Mr. Truman French, rospecting for the Nova Scotia Coal Company, discovered the fine m of coal now known as the Acadia seam, and presumed to be equiva- t to the Main seam of the Albion mines. The first opening of this seam on the area under consideration, near its western boundary, from which t it was traced north and south, as described in treating the general tribution of the coal seams.

Acadia seam.

Acadia colliery.

Acadia colliery.

The Acadia colliery, locally known as the Acadia west slope, is situated r the south-western corner of the Carmichael area, and within the village Westville. Two slopes, corresponding in dimensions to the No. 3 Gregor slopes, have been sunk on the Acadia seam to a depth of about) yards from the crop.

Section of Acadia seam

The section of this seam and the strata immediately overlying, as mea- ed in the air shaft of this colliery, is as follows:

		Ft.	In.	Ft.	In.
Brown carbonaceous shale				4	6
Black bituminous oil shale				0	7
Brown carbonaceous shale				6	6
Good coal, (1st bench)	Fall coal	2	9		
Good coal, (2nd bench)	Fall coal	3	6		
Light arenaceous fireclay or holing		0	3		
Good coal, (3rd bench)	Bench coal	3	8		
Coarse hard coal with iron pyrites, easily separated by dressing from the other coals	Bench coal	0	1		
Good coal, (4th bench)	Bench coal	3	3		
Coarse coal of fair quality	Bench coal	2	4		
Coarse coal not taken out	Bench coal	2	4		
				18	2
				29	9

Above the section given, no details for a column of strata can be pr cured, no record having been preserved of the numerous pits in the ov lying measures. The remains from these pits, however, will enable me state that at this colliery the seam is overlaid with a great mass of barr measures, consisting of black and brown carbonaceous and argillaceo shales, with occasional bands of dark arenaceous shale, and at least two th bands of thinly laminated sandstones of a general white colour with bla partings, as in the sandstones described in the Forster pit section. Und the seam there is a yellowish-drab *Stigmaria* underclay of at least four fe in thickness. The measures are then concealed for forty-two feet, at whi point a heavy bedded sandstone appears, of a light brownish-drab colou containing, where exposed in a quarry near the Acadia slope, lar *Stigmaria* roots well preserved, as well as occasional stems of *Lepidode dron.*

Black shales

No faults.

At this colliery the seam has been proved to be without fault, by the ma level, which now extends about 500 yards south and 400 yards north, t exact direction across the area being N. 41° W., (or N. 18° W. magneti corresponding to the dip of the seam, N. 49° E. (or N. 72° E. magnetic which varies only in inclination, being 19° at the surface and about 2 at the lowest level. The under-ground workings are on the count balance system, and are remarkably regular and well laid out. Count balances are driven 15 feet wide and 100 yards apart, throughout t workings. An air course 8 feet wide is also driven up at 10 yards to t left of each counterbalance. Working bords are 15 feet in width, with feet of pillar, 75 feet of barrier being left above the main level.

Counter-balance system.

MACHINERY.

Machinery.

The platforms at the head of the slope are roofed in. They exte from the mouth of the slope to the banks, and also to the shutes over t railway track. At this mine the fine slack is not sold, being careful screened out, the rest of the coal being divided into two sizes, *round* a *chesnut.* The drawing engines were built in New York, and a fair specimens of the best type of American engines, being compact a easily handled, with none of the slightness of design usually observable American machinery. They are horizontal high-pressure connect engines, 16 by 48 inch cylinders, working by a 24-inch pinion into a 1 feet spur-wheel on a 14-feet drum. The engine house is of brick and c stone, with a corrugated iron roof. Pumping is effected by a small donk engine, which is also arranged to hoist bank coal to the screening pla form, the quantity of water in this mine being so insignificant that a tw inch column-pipe is sufficient to deliver it.

Drawing engines.

SECOND SEAM.

[T]he discovery of the Acadia seam was followed by the discovery of a [sec]ond seam, underlying at about 160 feet, by Capt. Blacker of the [Ac]adia colliery. At the pit sunk by him the following thickness was [fou]nd:— Second seam.

	Ft.	In.
Shaly coal	3	10
Good coal	7	8
	11	6

[T]he bench known as *good coal* seems, from the specimens I have seen, [to b]e of a shaly character, and none that has come before me would be [sal]eable. On the Carmichael area this is opened by only one trial-pit, [now] filled up.

AREA NO. 3.

[U]pon the No. 3 Acadia area no coal has been found, but from the [pre]sence, as proved by trial-pits, of the black shales overlying the Main [sea]m, it is probable that the representatives of this and underlying seams [occ]ur beneath a portion of this area to the west of the McCulloch-brook [fau]lt. Of the size or character of the coal no information can be obtained [wit]hout extensive prospecting. The only opening which is near this area [is t]he Culton adit, and from the strike of the Culton seam at that point, [it m]ay be presumed that it will continue on to No. 3 area. Area No. 3.

RAILWAY.

The Acadia Coal Company have built a fine single-track railway of [ab]out three and a half miles in length, the main line extending from the [we]st slope to the track of the government railway at a point near Coal [Mi]nes station, and passing through the Acadia village near the McGregor [col]liery, with which it is connected by sidings. From the junction at the [rai]lway station the coal is conveyed over the government railway to the [Ac]adia loading ground at Fisher's Grant, on the east side of Pictou har[bou]r, near the entrance. The shipping wharf extends into the harbour 850 [fee]t to 26 feet of water at low tide. It is a well built structure, 20 feet [in] height, with shutes at both sides and end, empty trains being made [up] on a centre track. Railway. Loading ground.

BUILDINGS.

Thirty double houses have been provided for miners and labourers at the [Ac]adia village, which is very tastefully laid out in regular streets and [av]enues, the houses being very substantially built, and of a much better [cla]ss than it is usual to provide for like purposes. Buildings.

The rest of the plant at both slopes, including the blacksmith and [ma]chine shops, office building and overmen's houses, is very complete.

INTERCOLONIAL COAL MINING COMPANY OF MONTREAL.

Intercolonial Coal Company.

Two mining areas are owned by this company, the Bear Creek area to the south of the Carmichael area of the Acadia Coal Company, and the Sutherland area, which lies to the north of the area of the General Mining Association.

BEAR CREEK AREA.

Bear creek area.

The Acadia seam was opened upon this area soon after its discovery in 1865, at a point known as Campbell's pit, near the north line of the area, and from this pit, as worked by the then owners of the area, and subsequently by the agents of this company, a considerable amount of coal was taken for consumption in the immediate neighbourhood. After a careful survey by Mr. William Barnes of Halifax, a competent mining engineer, (which survey will again be alluded to) the company decided upon the location of the present colliery.

Drummond Colliery.

Drummond colliary.

The erection of buildings and machinery at this colliery and the first work at the present slopes was commenced about November, 1867, since which time works of considerable importance have been erected, a railway has been built, and a large amount of coal (about 70,000 tons) has been shipped.

The section of the Acadia seam at this point is as follows, the measurement being taken in the air shaft of the colliery:

	Ft.	In.
Good coal with a smooth parting two feet nine inches from the bottom, (*full coal*)	5	[illegible]
Light gray soft fireclay; it varies slightly in thickness; (*holing*)	0	[illegible]
Good coal, top bench }	5	6
Gray hard coal, giving a pink ash. }	0	6
Good coal, second bench }	4	6
Coarse coal, not worked }	2	1
	18	7

Under-ground Workings.

Under-ground workings.

The present workings consist of two working slopes driven about 900 feet from the crop of the seam, the dip being about 16° at the surface decreasing to 14° at the lower level, at 730 feet from the surface. The size of these slopes is 9 by 9 feet, with a central barrier of coal between them of 28 feet, each slope having a single track and travelling-way. Main levels for two lifts have been driven from the slopes *north* and *south* upon the seam, the north levels being worked from No. 1 slope and the south from No. 2; thus far I believe the lower levels have been most extensively worked, a considerable amount of coal being left

the crop for safety. I have not had an opportunity of examining a iled plan of the workings, but my inspection of them would lead me elieve that the system of pillarage is planned with more than usual ard for safety. Both the post and stall and counterbalance systems of *ing* the coal were at first tried with a view of ascertaining their comative economy, and I believe that Mr. Dunn has selected the counternce system for the future working of the mine.

But little water has as yet been met with, and it is at present raised by er cars, no pump having been found necessary.

Over-ground Works.

The arrangements at the surface seem exceptionally well planned and e given great satisfaction. At the head of the slopes a large heapstead covered screening platform is erected for the separation of different s and qualities of coal, and for banking out. The coal boxes are drawn o this platform in trams of from five to twelve (holding from 500 to 600 unds each) and thence delivered by dumps on to the screens, where the l is separated, as at the Acadia colliery, into three sizes: round coal, coal and slack. The platform extends over eight railway tracks, four each slope; its floor is level with the top of the bank, for banking out, and shipping bank-coal a railway track is run along the foot of the bank, and m this level the bank cars are raised to the main platform in a cage ed by a small donkey engine, which is also arranged to drive a circular v for the car shop of the colliery. Over-ground works.

The drawing engines are horizontal connected engines of about 50 minal English horse-power; they are of Scotch manufacture, and are ed with an extremely ingenious arrangement of friction gearing, by eans of which the two slopes may be worked independently, by one gine, a matter of great convenience. Engines.

Railway.

The railway of this company extends from the Drummond colliery to eir shipping wharf at Granton on the Middle River, near Abercrombie oint, the position of which will be seen on the map. The main line of ngle-track railway is laid with 56-pound rails, with the new steel scabbard int, which has proved so successful on the Pictou and Truro branch of e Nova Scotia railway. This railway was built in 1868 by Mr. Joseph Moore, contractor, in the most complete manner, the track being well llasted with broken sandstone and a coarse conglomerate from the cutngs near Waters's Brook, the culverts of cut stone, and the bridge of estlework with cut stone foundations. Railway.

The rolling stock of this railway consists of three locomotives, miscelneous platform and construction cars, and sixty new coal waggons carry- Rolling stock.

ing from six to seven tons of round coal each, twenty of which were bui at the Drummond colliery car shop. In connection with the railway are pr vided at the colliery, car shops, locomotive-sheds and weigh-houses. Th length of the main line of railway from the colliery to the wharf is abou seven and one quarter miles, which, with sidings, turn-outs and standin tracks at the colliery, will probably raise the total length of single track about ten miles.

Shipping wharf.

The shipping wharf of the Intercolonial Coal Company is a fine structur of wood upon stone and crib-work piers, extending in a curve into the chan nel of the Middle River to about 22 feet of water. The arrangement at th platform of the wharf is such that there is a slight incline of one trac downward from the shore to the end of the wharf, and thence a furthe down grade on a second track back to the shore, the design being that a fast as coal is required at the shipping places or *shutes*, the full cars ar allowed to run by their own gravity to the point required, whence, o being emptied, they will again return by their own weight to the shore, t be made up into *empty* trains. They are switched back at the end of th wharf on to the *empty* or inside track, running parallel to the *full* track upon which they are pushed by the locomotive in coming from the colliery This arrangement has, I believe, given great satisfaction, as it result in a saving of the horses usually necessary for handling coal cars at th shipping wharves.

The railway and wharf were opened for traffic about the 1st of October 1868, and before the close of navigation several thousand tons of coal wer shipped. During the present season the colliery has been in successfu operation, and a considerable quantity of the coal has found a market i the provinces of Ontario and Quebec.

In the description of the general distribution of the coal in the Bea Creek synclinal it has been stated that at a few hundred yards to th south of the Drummond Colliery the crop of the Acadia seam come against the West fault. The fact that the crop of the seam was here los upon a fault "with a S. W. upthrow and a bearing of N. 10° W." mag netic, (or N. 33° W. astronomical) was proved and stated by Mr. Barnes A few yards to the west of the spot where the coal of the Acadia sean was lost another seam of inferior coal, about three feet in thickness, wa found, and beyond it, to the south-west, a second fault with a south-wes upthrow was observed, bringing up red and gray sandstones. These sand stones I have examined and believe to belong to the Millstone Grit series

West fault.

The first fault mentioned appears to coincide in position and bearin with the general run of the West fault, and, as it will certainly be th western boundary of the workable coal, I have in the map shown it as tha fault, but it is quite possible that here the great West dislocation may tur

w yards, leaving a small patch of the lower portion of the coal measures ne west of Mr. Barnes' first fault, its throw being completed by the ond fault found by Mr. Barnes, bringing up the Millstone Grit.

The amount of coal of the Acadia seam removed by this fault, as at sent understood, will be unimportant. This is known from the fact the measures overlying the seam have been traced along the east side ne fault, and as they dip at very low angles it is probable that only some or 100 yards of coal next the crop will be cut off by the fault. No son is at present known why the second levels from the Drummond iery should not run around regularly to the south-eastern portion of area.

SUTHERLAND AREA.

But little work has been done upon this area, and no coal has as yet n opened. It will be seen that the North fault runs diagonally through cutting it into two portions. To the south of this fault the area is bably underlaid with the lower seams or a portion of them. The ntreal and Pictou seam, and any seams which may be found above it, l, if no dislocation exist, turn to a westerly dip upon this area, and at a chains from the east line their crops will come against the fault. Sutherland area.

The coal in this area might, perhaps, be successfully worked in connec- n with the Montreal and Pictou area, and a small portion of the northern t of the area of the General Mining Association.

NOVA SCOTIA COAL COMPANY OF NEW HAVEN, CONNECTICUT, U. S.

This Company own one mining right of three and one-half square miles extent, known as the French Area. Nova Scotia Coal company.

FRENCH AREA.

This mining area is situate to the north and west of the Carmichael a of the Acadia Coal Company. The workings consist of a slope upon e Acadia seam, driven 236 feet from the crop, from which a few irregu- working places have been opened and several hundred tons of coal sed. The angle of dip is here 28° at surface, increasing to 35° at e bottom of the slope. A section of the Acadia seam was measured out 140 feet down the slope, and is as follows, the measurements being duced to thicknesses at right angles to the plane of the seam: French area.

ACADIA SEAM. Section of Acadia seam.

	Ft.	*In.*
Good coal, not seen, the thickness and quality being on the authority of Mr. T. French, agent of the Nova Scotia Coal Company..........	2	6
Good coal..	4	8

	Ft.	In.
Dark brown arenaceous fireclay, compact and hard; the thickness varies, the average being........	0	1
Good coal, finely laminated........	2	
Shaly coal and dark brown coarse arenaceous fireclay in thin beds, known as *stone parting*........	0	
Good coal, locally known as the *middle bench*........	2	
Dark brown arenaceous fireclay........	0	
Coarse good coal, giving a reddish ash........	1	
Dark brown soft fireclay parting........	0	
Good coal with a coarse and somewhat *twisted* structure; the good quality of the coal is given on the authority of Mr. French........	2	
	17	2

SECOND SEAM.

Second seam.

The section of the second seam at the pit a short distance west of th Nova Scotia slope, is stated by Mr. French to be as follows:

	Ft.	In.
Shale and coal........	3	
Good coal........	9	
	12	

NOVA SCOTIA COLLIERY.

Nova Scotia Colliery.

Until the present season the opening on the Acadia seam has lain idle but the erection of works is now in progress, and it is hoped that the co liery will be in active operation by the opening of the season of 1870. A survey has been made and ground broken for a railway, and a wharf i being built near the Intercolonial Coal Company's shipping wharf on th Middle River. It is designed that the colliery shall be capable of ship ping some 600 or 700 tons of coal per day.

Railway and wharf.

The exact position of the spot where the crop of the Acadia seam will b lost upon the West fault, upon this area is still an uncertainty. The seam ha already been found 396 yards to the north-west of the working slope, an could probably be traced a short distance farther. As the angle between th strike of the seam and the bearing of the fault is very small, the dislocatio will encroach but little on the *deep coal* at this mine, for a considerabl distance from the slope. In this connection may be mentioned an adit o the right bank of McLeod's Brook near its junction with the Middl River, locally known as French's Tunnel. This was driven for som distance eastwardly upon a bed of several feet in thickness of black shal and shaly coal, which, at one time, was imagined to represent the Acadi seam. This bed is however situated to the west of the West fault, an it would appear to belong to the Millstone Grit. As it is supported by *Stigmaria* underclay it may, in spite of its impurity, be considered a tru coal seam, but is not likely ever to prove of any value.

West fault.

MONTREAL AND PICTOU COAL COMPANY OF HALIFAX, NOVA SCOTIA.

The Montreal and Pictou area is situate to the north of that of the General ining Association, to the west of the Sutherland area of the Intercolonial ompany, and is bounded on the east by the east bank of the East River. he northern limit of the Productive coal measures upon this area is the ne of the great North fault. As yet no regular works have been comenced, though the company have been at considerable expense in sinking a it upon what has been known as the Montreal and Pictou, or Haliburton eam. From verbal information given me by Mr. Haliburton, Managing irector of the company, and a journal of progress kept by Mr. William rain, former agent of the company, the following facts with regard to this it are submitted. Montreal and Pictou Co.

According to Mr. Brain's record, the following strata were intersected sinking; the thickness being given *vertically to horizon*, the dip being . 43° E. (or S. 20° E. mag.) $< 65°$. The descriptions of strata are based pon a personal examination of the pit *débris* : Section vertical to horizon.

	Ft.	In.
Bluish-gray argillaceous shale	13	0
Compact light-gray sandstone	0	10
Black argillaceous shale and fireclay interstratified with one another	10	0
Coal (bench *a*)	10	6
Black carbonaceous fireclay	10	6
Sandstone, the colour not given	3	0
Fireclay with arenaceous bands	3	0
Black carbonaceous shale	3	0
Coal (bench *b*)	9	0
Coarse coal and shale (bench *c*)	2	0
	64	10

At a depth of 100 feet from the surface, a cross-cut or *stone drift* was driven on the underlying measures, intersecting the following strata, the measurements being taken on a horizontal line : Horizontal section.

	Ft.	In.
Fireclay	9	0
Coal (bench *d*)	2	6
Fireclay	9	0
Coal (bench *e*)	15	0
	35	6

According to the record these strata must have been in the disturbed measures of a fault, as the section of the shaft shows angles varying from 30° to 85° of overturn or northerly dip. From the level at 100 feet, the shaft was sunk to a depth of 177 feet, without getting the benches of coal Shaft sunk.

d and *e*, and in the bottom of the shaft a bore-hole was put down $27\frac{1}{2}$ feet further, passing through sandstones, shales and fireclays only. At a depth of 163 feet from the surface a cross-cut was then driven from the shaft to bench *a*, passing through bench *b*, which was only five feet in thickness. With regard to work done in this bench, the following information was obtained from Mr. Haliburton; the workings, being full of water at the time of my visit, could not be examined.

ross-cut.

"The upper bench (*a*) where cut by the stone drift from the pit was ten feet six inches in thickness, yielding three and a-half feet of workable coal; upon this bench a level was driven seventy yards south-west. The thickness was at one time reduced to two and a-half feet, after which it increased to twenty-five feet, yielding fourteen and a-half feet of workable coal, the size increasing and quality improving going westward."

Level.

"At sixty yards west of the pit a stone drift was driven across the dip through the underlying measures eighty-four feet, and a bore driven thirty-four feet farther without meeting any of the lower benches (*b*, *c*, *d*, *e*) of coal. The strike at the western face was due west (or S. 67° W. astronomical) and turning rapidly toward the north-west."

Cross-cut and bore-hole.

In driving the western drift twelve feet of dark brown carbonaceous fireclay were intersected, of which some 300 tons were taken out and sold to the Crown Brick and Pottery Company, of New Glasgow, at $0.75 per ton, and I am told proved of very good quality. Eastward from the Montreal and Pictou pit the upper bench (*a*) was found to rapidly thin and deteriorate, and work in that direction was soon stopped.

Fireclay.

In explanation of the facts just given it can only be said that it is probable an east and west dislocation runs quite near the Montreal and Pictou pit, bringing the lower benches (*b*, *c*, *d*, *e*) into the position in which they were found, the exact direction and dowthrow of which have not been properly observed while the workings were in progress.

A small seam has been proved upon this area upon the old road to Fraser Ogg's quarry, the thickness of which is given by the Montreal and Pictou Company's record as eighteen inches. The coal from this pit resembles the Stellar oil-coal from the Frazer mine of the Acadia Coal Company, and burns in much the same way, igniting with ease and throwing off small sparks or jets of flame; and it is possible that it is the representative of the Stellar seam on the north rise of the Albion trough. Its stratigraphical distance from the Montreal and Pictou seam appears to be about 200 feet, but with the possibility of intervening dislocations this may be far from correct.

Oil-coal.

I have already alluded to the possibility of coal beds being found overlying the Montreal and Pictou seam, and to several unproved crops which

known to underlie the supposed Oil-coal; one, probably representing n A of Section 4, is seen upon the old quarry road, near the brick-yard he north of the Montreal and Pictou pit.

MESSRS. SINCLAIR AND HALIBURTON'S CULTON AREA.

)f the mining areas lying to the west of the East River, either wholly artially underlaid with the workable coal seams, there remains to be ced only one, the Culton area, lying to the south of the Intercolonial l Company's Bear Creek area. Sinclair and Haliburton's Culton area.

'he Culton adit has already been described. This opening, with a bore- near it, seems to prove the existence of a seam of six feet in thickness, re undisturbed, of good coal, on the northern portion of the area. The bability of a second seam has already been alluded to, and if, as indi- ed, the Culton seam is the equivalent of the Main or Acadia seam, resentatives of the lower seams of Section 4 should underlie a small tion of the area probably bounded by the West, the South, and the Culloch-brook faults; but as no openings exist upon any such seams statements can be given of their size or quality. Culton adit.

n conclusion I would state that an Appendix to this Report is in course of paration, in which descriptions and analyses of the different coals of this ion will be given, together with the results of such practical trials of ir economic value as steam and gas producers as I have been enabled make; together with a collation of many facts and analyses already pub- ed which could not be conveniently introduced into the body of the port. In the Appendix will also be noticed several deposits of iron ore Pictou county, which have received examination during the past two sons, with assays and analyses of the specimens obtained from them. Appendix with analyses of coals. Notice of iron ores.

I have the honour to be,

Sir,

Your most obedient servant,

EDWARD HARTLEY.

REPORT

OF

MR. ROBERT BELL, F.G.S.,

ADDRESSED TO

SIR WILLIAM E. LOGAN, F.R.S., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY,

KINGSTON, April 20, 1867.

SIR,—I beg leave to report that in pursuance of your instructions I ›ceeded in the month of June last to make a geological examination of ckburn, Drummond and St. Joseph's Islands, as well as some additional :veys on the western portion of Grand Manitoulin Island, in continua- n of the work of the previous season. Mr. Murray having ascertained main geological features of these islands, it was only necessary for to trace the boundaries of the formations in more detail. I was assisted these explorations by Messrs. W. W. Kirkpatrick, John Cadenhead, G. Francis and Dr. John Bell. The last named gentleman also made a anical *reconnaissance* of the islands, and a list of the plants collected and served by him is given in the Appendix.

TOPOGRAPHY, SOIL AND TIMBER.

Lakes of Grand Manitoulin.

The principal addition made to our knowledge of the topography of and Manitoulin Island consisted in determining the position, form and nensions of Lake Mudgee-manitou, a shallow sheet of water about five les long, with deep bays, lying between Lake Kagawong, which was sur- yed last year, and Gore Bay. It was proved beyond a doubt that this e empties into Lake Kagawong. The outlet, whose course I traced all way, is a brook sufficiently large to be navigated by canoes, except in

low water. Having also fixed with more accuracy the position of the Niagara escarpment from Lake Kagawong to Lake Wolsey, another prominent feature is added to the map of the island. The best soil in this, as in other parts of Grand Manitoulin, is found along the out-crop of the red marl band.

Cockburn Island.

The interior of Cockburn Island was carefully explored. The surface in this island is generally rolling. In the centre, which appeared to be the most elevated part of the island, the higher ground consisted of yellow sand, supporting a growth of sugar-maple, beech, red oak, and other hard woods. The sand appeared to be underlaid by boulder drift, and was deeply cut by the channels of brooks. The limestone rock was exposed only in some places. The lower levels, forming a considerable portion of the whole area, were occupied with tangled cedar swamps, very difficult to penetrate. Here and there we met with a shallow lily-pond, surrounded with open peaty meadows, but upon the whole, the island cannot be said to be well watered. On approaching the shore from the interior, ridges and terraces of sand and shingle were found at different levels all round the island. Unlike Grand Manitoulin, the woods have not been seriously injured by sweeping fires.

Drummond Island.

Drummond Island lies lower than any of the other islands of the Manitoulin group. It is almost useless for agricultural purposes, the surface being nearly altogether rock and swamp. A number of ponds are found in the southern part and one brook in the northern. On the north-east side the water is deep and free from obstacles, but on the north-western and southern sides it is shallow and much interrupted by reefs and small islands.

St. Joseph's Island.

St. Joseph's Island is remarkable for the immense accumulation of drift which is piled upon it, obscuring the underlying rocks. In some places it rises to upwards of 300 feet above the level of Lake Huron. The island is nearly all well wooded, chiefly with hard maple, but the soil is light and stoney. Unlike the other islands, very few ponds occur upon it, and numerous small brooks run down into the lake on all sides.

GEOLOGICAL STRUCTURE.

w anticlinals

In my Report of last year it was shewn that a series of low anticlinals traverses the Grand Manitoulin Island from north to south, and that, owing to the action of denuding agencies, these have given rise to the deep bays along the northern side. The channels separating the various islands of the Manitoulin group have been formed in the same way. The uniformity which thus pervades the whole chain may be perceived by an inspection

f the map, the channels between the different islands being merely deeper uts than those forming the bays of the Grand Manitoulin. The massive mestones of the Niagara formation constitute, as it were, the back-bone f Grand Manitoulin, Cockburn and Drummond Islands, as well as of the eninsula between Lake Huron and Georgian Bay, on the one hand, and etween the same lake and the St. Mary's River on the other. The dip of the trata is everywhere towards the centre of Lake Huron, and the inclination o the horizon low, being estimated, on an average, at from forty to fifty eet in a mile.

Trenton Group.—In the broader portions of Grand Manitoulin, the Clinton, Hudson River and Utica formations and the Trenton group rop out in succession from beneath the Niagara strata. The Trenton formation constitutes the most northern points of the island, and its continuaion is seen in numerous small islands at about the same distance from the general outline of the Huronian rocks forming the north shore of Lake Huron, all the way westward to St. Joseph's Island, across which it trikes and enters the state of Michigan at Neebish Island. As stated n the Geology of Canada, page 196, limestones of this group are found t Gravelly Point, (the north-east extremity of St. Joseph's Island) and gain resting on sandstone of the Chazy formation on Campment d'Ours; he distribution in this region being much obscured by drift, no new facts n regard to it have been discovered. Trenton group.

The Utica Formation has not been met with, in place, west of Maple Point (on Grand Manitoulin Island) but its position at the summit of the Trenton is indicated on St. Joseph's Island by loose fragments of the black bituminous shale. Utica formation.

Hudson River Formation.—The edge of the plateau formed by the Hudson River formation presents itself in a high bluff all along the north side of Grand Manitoulin from Maple Point to Julia Bay. Gore Bay, in this interval, lies in a deep notch cut out of the plateau. The strata are finely exposed in the bold escarpments on either side of this bay. The southward dip, at the rate of about one in fifty, is here quite perceptible. Local slides and debris obscure the outcropping edges of the beds in some places, and the following section, from the water's edge upwards, was not obtained in one straight line, but by connecting two exposures lying close to one another, and is presumed to be almost as correct as if measured continuously. It was obtained on the east side at the entrance to the bay, commencing at the level of Lake Huron. Hudson River formation. Section at Gore Bay.

Ft. In.

1. Bluish and drab-grey argillaceous and finely arenaceous shale—bands of darker and lighter shades alternating—crumbling and wasting away easily under the influence of the weather, interstratified with beds a few inches thick and from two to fifteen feet apart, of fine grained First escarpment.

	Ft.	In.
grey shaly sandstone and bluish-grey limestone. The limestone bands are composed of comminuted organic remains, principally small corals, but in addition there were observed a small trilobite, a *Leptæna*, an *Orthis*, and *Ambonychia radiata*. The sandstone bands hold *Modiolopsis modiolaris*..........	81	0
2. Soft fine grained bluish-grey calcareous sandstone and finely arenaceous limestone in beds from one to six inches thick. The surfaces are uneven..........	6	4
3. Measures concealed..........	80	0
4. Mottled drab and grey soft argillaceous and finely arenaceous limestone, (the more calcareous portions being finely crystalline and gray). The beds are from one to six inches thick, in bands of from two to four feet, alternating with others of about the same thickness, of crumbling bluish-drab finely arenaceous shale with nodular calcareous seams. Both the soft and hard bands are unevenly surfaced and of a nodular character. The fossils are *Petraia*, *Stenopora fibrosa*, *Orthis lynx* and a smaller species of *Orthis*, a large *Atrypa*, an *Avicula*, a *Strophomena* and an *Orthoceras*..........	26	8
5. Dark drab-grey soft brittle fine grained arenaceous somewhat crystalline limestone, in beds from one foot three inches to three feet six inches thick. It holds a small silicified *Orthis*..........	10	6
6. Greenish and bluish-gray soft finely arenaceous limestone, in beds from one to three feet thick, separated by layers of bluish-grey shale from two to ten inches thick. The limestone holds nodules of white gypsum from two to three inches in diameter..........	27	7
7. Brownish soft unevenly surfaced earthy looking limestone, in beds of about two inches..........	8	8
8. Brownish-drab and grey limestone in uneven beds from four to ten inches thick. Fresh fractures present a mottled drab and gray color, the grey patches having a crystalline and the drab an earthy appearance. The beds contain rusty cavities lined with rhombohedral crystals of calcareous spar. The fossils are *Stromatopora concentrica* and *Favosites Gothlandica*. Near the top is a nodular shaly layer holding iron pyrites, which, on decomposing, stains the face of the cliff with red oxide of iron..........	5	3
9. Brownish and drab-grey thin irregularly bedded or shaly limestone holding *Stenopora fibrosa*, silicified and abundant, together with cavities lined with calc-spar crystals. This band forms the crest of the main escarpment..........	8	0
10. Brownish and purplish-grey uneven surfaced limestone, mostly in thin beds (the thickest being nine inches). Some of them are very dark and bituminous. The mass weathers yellow, and holds abundance of *Stenopora fibrosa* in a silicified state..........	37	6
	291	6

Second escarpment.

This last mass (10) rises at a short distance back from the main escarpment in a second cliff above it and, gradually approaching, at a point half a mile nearer the head of the bay than the locality at which the previous portion of this section was measured, it joins the main escarpment and is added to its height.

Third escarpment.

About a hundred yards still further back, and after an interval of :oncealment of about seventeen feet, a third terrace rises to the height of wenty-eight feet, but appears to gain in elevation as it recedes eastward. t consists of soft brownish and buff-grey thinly bedded bituminous limestone, aving a conchoidal fracture, and holding small irregular chalky nodules. The fossils, which are mostly silicified, consist of several species of *Orhoceras*, *Orthis*, corals, including *Favosites Gothlandica*, and the small ystidean which elsewhere on Manitoulin Island characterizes the Clinton ormation. This terrace is considered to form the base of this formation.

Fossils.

Proceeding westward from Cape Robert, on the Grand Manitoulin, the Hudson River formation is next met with along the north side of Drummond Island, where the upper beds, which are, as usual, of a massive alcareous nature, form a strip about seven miles long and two broad. On Sulphur Island the Hudson River shales lie upon the Huronian rocks, (Geol. Can. page 219). Most of the small islands between Chippewa Point (the northwest extremity of Drummond Island) and St. Joseph's sland come within the strike of this formation. On the latter island it s deeply covered by drift, and no exposure of it has yet been found, so hat its position is, to a great extent, determined by the summit of the ext lower and the base of the next higher formation. The upper beds vere however discovered in place, on a small island close to its eastern hore, about two miles and a-half north-east of the old Fort St. Joseph, on he southern point of the island.

Huronian rocks.

Clinton formation.

Clinton Formation.—The distribution of the Clinton formation on Grand Manitoulin from Lake Kagawong westward to where it leaves the sland was, by additional observations, more minutely determined than ast year. On Drummond Island this formation occupies a strip rather nore than two miles broad. The line marking its base runs westward across the island from Colton Bay to Vermont Harbor * As on Mantoulin Island, it consists of grey and drab, somewhat argillaceous limetones, mostly thinly bedded. It is characterized here, as elsewhere, by rregular chalky nodules. Very few organic remains, however, were ound, and in this respect it would appear to differ from the portion on Mantoulin. At the summit of the formation the stratum of red marl which, on Grand Manitoulin, has been taken as representing the iron-ore band, was found in one place a short distance east of Medford Bay. This soft band probably follows the channel between St. Joseph's and Lime Islands, and he existence of a similar marl further west, at Sucker Creek, is referred to in the Geology of Canada, page 321. The formation may be traced from Drummond to St. Joseph's Island by the fragments of Hudson River

Drummond Island.

Iron-ore band.

* Most of the bays marked as "harbors" on Mr. Whitney's map of Drummond Island are only *boat* harbors.

rocks found upon a number of the small islands between the two. Its base appears to skirt the south side of St. Joseph's Island as far as Hay Point and thence to strike across the St. Mary's River to the opposite point i the state of Michigan.

Niagara formation.

Niagara Formation.—On Grand Manitoulin the base of the Niagara formation was followed out, by actual measurement, through all its windings from Lake Kagawong to Lake Wolsey, but its position, as thus determined, does not differ perceptibly from that assigned to it from the observations of last year. From Lake Wolsey, westward, this formation holds the shore to the extremity of the island. Leaving the west end of Grand Manitoulin, the lower boundary (being the northern geographically) of the

Cockburn Island.

Niagara strata keeps to the north of Cockburn Island, which, after careful examination, was found to lie wholly upon this formation. It next cuts off the northern part of Drummond Island, passes just south of the southern point of St. Joseph's Island and appears to enter the mainland of Michigan

Lime Island.

near Sucker Creek. Lime Island, on the American side of the international boundary, and a few of the small islands between St. Joseph's and Drummond Islands are situated upon the Niagara rocks.

Regarding the Niagara formation on Grand Manitoulin Island, nothing worthy of special mention, besides the facts relating to its distribution already referred to, was observed, in addition to what I had the honor to communicate to you in my Report of last year. It was then stated that the breadth of the formation averaged nine miles, and the dip, to the southward, one in forty-five.

Cockburn Island has a breadth of nine miles from north to south, and the dip of the strata being the same as the Grand Manitoulin, the thickness of the Niagara formation, of which this island is wholly composed, will here be

Dolomites.

about 400 feet also. Along the north shore of the island the rocks (which must be near the base of the formation) consist principally of soft buff-colored bituminous dolomites, suitable for building purposes, and holding a species of *Leperditia*. They are characterized by a conchoidal fracture, which, in natural exposures, parallel to the bedding, gives rise to a succession of small depressions resembling plates and saucers in size and form.

Marble Head. Drummond Isd.

These rocks were referred to in my last Report as occurring at Mildrum Point, (the north-western extremity of Grand Manitoulin). The same beds have been quarried for a considerable time at Marble Head, (the north-eastern extremity of Drummond Island. Interstratified with these, on the north side of Cockburn Island, in some places there are found slaty and more bituminous bands of a dark color, and in others even-surfaced beds of a bluish-grey color, which, if not too soft, may be found suitable for flagstones. In the harbour at Thompson's Point (the northern extremity of the island) the buff-colored beds, which vary from two to three

ıches to a foot in thickness, present a very rough spongy or pitted ppearance externally, and internally are full of cavities from the presence f vast numbers of casts of *Pentamerus oblongus*. The same fossil is Pentamerus. ɔund in some of the beds throughout the whole formation on this and)rummond Island, as well as Grand Manitoulin. These soft bituminous rocks re, in some places, overlaid by grey uneven surfaced bituminous limestone, olding obscure fossils and full of small lenticular cavities, mostly transerse to the bedding. On the south side of the island, the upper beds, onsisting of grey somewhat bituminous limestone, are seldom seen, the hore being formed of sand and shingle ; while on the east and west sides the mestones are exposed almost continuously along the beach. The beds are enerally thick, some of them attaining upwards of six feet. Most of them re light grey in color and of a saccharoidal texture. In the interior of the sland, especially towards the northern side, similar beds are occasionally xposed. They are however seldom seen in the form of cliffs, and lthough the northern slope of the island is the most precipitous, much of it s buried under the drift. These thick beds, in general, contain few and l defined fossils. Certain beds, however, occur at the eastern extremity f the island, about two miles and a-half north of McLeod's Harbor, which re well stored with silicified fossils. Among them are two or three species f the remarkable fossil, *Huronia*, in a good state of preservation. But the Huronia. ommoner corals of the formation are by far the most abundant, and are beauifully preserved and weathered out. At the western extremity of Grand Ianitoulin Island, directly opposite to this locality, and in a corresponding eological position, the coral beds again occur, but none of the *Huronia* vere found in them. In a similar position on the west side of Cockburn sland, however, two loose specimens of this fossil were found with the orals. A diligent search along the east shore of Drummond Island, on he opposite side of the False Detour, and in a like geological position, ailed to discover any examples.

On Drummond Island the Niagara formation has nearly the same descripion as on Cockburn, the two islands being quite like one another geoloically, except that the former has in addition two of the lower formaions on its northern side. At Marble Head, the eastern extremity, vhere a larger section is obtained than at any other place upon the island, he shore is occupied by a soft drab colored bituminous calcareo-argillaeous rock with a large conchoidal fracture. The beds varying in thickness rom an inch to a foot, and are marked by spongy lumps and by cavities conaining minute crystals of quartz. These beds are followed by fifteen or wenty feet of light and dark grey and reddish-grey bituminous limestone, he darker beds holding obscure remains of fossils and the lighter ones eing full of small cavities, which give the rock a very open appearance

when slightly weathered. Fresh fractures, beyond the influence of th weather, shew a white granular filling in these slits, and sometimes cal

Frazer's quarry.

careous spar. Above these beds, in Mr. Frazer's quarry, are twenty five or thirty feet of more thickly bedded drab and buff colored soft argil laceous limestone with a conchoidal fracture and easily broken. The fou thickest beds measure respectively seventeen, eighteen, twenty and twenty-four inches. When newly fractured, the bedding is seen i different shades, although the planes are not separable. Overlying thes strata are thick beds of grey limestone, which weather with rugge surfaces and contain of great numbers of *Pentamerus* and obscure corals Some of the higher beds are six feet thick.

From the neighborhood of Marble Head an escarpment of Niagar strata runs westward across the island to a point abreast of Harbor Island Here there is another quarry in a position which corresponds geologi cally with that of Marble Head. The lower six feet in the quarry con sist of brittle compact drab-grey limestone, in beds from four to eightee inches thick, breaking into regular blocks suitable for building, an separated from one another by flaggy layers from a quarter to half a inch thick. Above these are four and a-half feet of light grey limestone containing small empty cavities, in two beds, the lower a foot and a-hal and the upper three feet thick. These are followed by eleven feet of sof buff and drab limestone in beds from one to fifteen feet thick. White lim was formerly made at this locality.

Lime Island.

On the west end of Lime Island are two conspicuous terraces, the upper being about sixty and the lower twenty feet above the lake. The former is crowned with a ledge, in some places ten feet high, of thinly bedded grey limestones, with the empty lenticular slits so common in the limestones near the base of the Niagara formation on the other islands.

ECONOMIC MATERIALS.

Economic materials.

The lower portion of the Niagara formation on the west end of Grand Manitoulin and upon Cockburn and Drummond Islands has been already mentioned as affording a good building stone, and the probability of the

Flag stone.

thinner grey beds on the north side of Cockburn Island furnishing flags

Sandstone.

suitable for paving was also referred to. The light grey sandstone of the Chazy formation on Campment d'Ours has lately been quarried for the construction of a dwelling house at the Sault Ste. Marie, and found to answer extremely well.

Limestone.

The limestones referred to in this report are probably, with few exceptions, highly magnesian, and often true dolomites. They are in many

ices burned, and yield a lime which is well adapted for building purposes, ough, from the presence of magnesia, not well fitted for application to e soil, (Geology of Canada, pages 803, 804.)

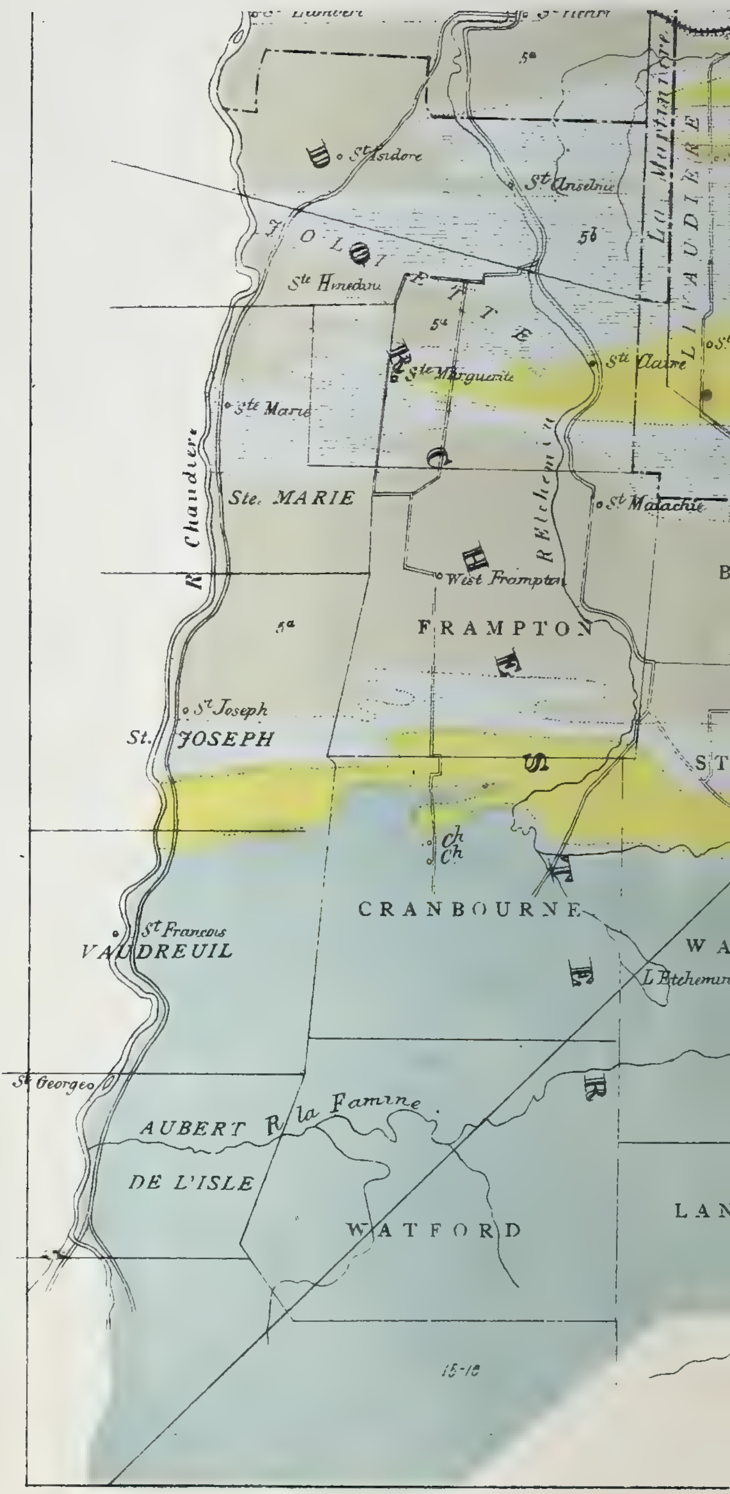
Rumors of coal, followed more recently by others of pitch and tar, und on Cockburn Island, have been circulated in that part of the coun-. These stories have had their origin in the fact that a large vessel aded with coal was wrecked some years ago near McLeod's Harbor, on e south-east side of the island, and the coal scattered for a long distance and down the shore. Pieces of it may still be found mixed up with e gravel and shingle. False rumon of coal.

It has also been reported that a large deposit of iron pyrites exists on e south side of Drummond Island, but we did not find it nor hear any-ing of it when on the ground. From the nature of the rocks forming rummond Island it is quite unlikely that any such deposit exists upon it. Iron pyrites.

I have the honor to be, sir,

Your most obedient servant,

ROBERT BELL.



St Isidore
St Anselme
La Martinière
LIVAUDIÈRE
St Claire
Ste Marguerite
Ste Marie
Ste. MARIE
R Chaudière
St Malachie
R Etchemin
West Frampton
FRAMPTON
St Joseph
St. JOSEPH
CRANBOURNE
St Francois
VAUDREUIL
L Etchemin
St Georges
AUBERT
R la Famine
DE L'ISLE
WATFORD

REPORT

OF

MR. JAMES RICHARDSON,

ADDRESSED TO

SIR WILLIAM E. LOGAN, F.R.S., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY.

MONTREAL, May 1, 1869.

SIR,—In accordance with your instructions I was engaged during two nths of the autumn of 1867, and the whole of the summer of 1868, racing down the valley of the St. Lawrence the rocks of the Quebec up in continuation of work previously done above the Chaudière River; in this, during the latter season, I was assisted by Mr. Walter McOuat. The portion of country examined is bounded on the northwest by the Lawrence, and by the province line of Quebec on the southeast, and ends from the Chaudière River to a point somewhat beyond the Temisata portage road; its length being about a hundred and twenty, and breadth from thirty to sixty miles. The investigation was conducted by usual method of measuring lines by pacing, and noting the exposures ock occurring on them. As far as possible, advantage was taken of roads streams, but the measurements were also carried across fields and through ods. Throughout a large part of the country on the southeast, however, y two thirds of the whole, owing to its being an unbroken forest, the ails could not be worked out so well as in the better settled part along St. Lawrence. In the former, sections were made along the government ds, which cross the stratification at considerable intervals, while in the er the margin of river, the numerous lines of communication in various ections, and the open fields, afforded every facility for making minute mination where the rocks were exposed. The whole of the measured es have been protracted on a scale of two and a-half inches to a mile, l transferred to the accompanying colored geological map on a scale of ht inches to a mile.

Area examined. Measurements. Map.

Structure above the Chaudière.

In the Geological Report of 1863-66, p. 29, in describing the stru of the country above the Chaudière, the following statement occurs ; " previous work of the Survey had demonstrated the general struc of the region, and had shown that between the great overlap fault w is the limit of the Quebec group on the northwest, and the overl unconformable Upper Silurian rocks on the southeast, two main antic axes, affecting its distribution, were traceable from the state of Ver to the Chaudière River, and beyond. The more northwestern o these runs from the mouth of the Boyer River on the St. Lawre through Stanbridge, and the more southeastern from St. Mary's on Chaudière by Danville and Melbourne, through Potton, a subsid anticlinal branching from it at Melbourne, and running through the v of Sutton. Of the synclinal forms resulting from these anticlinal axes first, or northwestern one, ranges from Farnham through Lauzon ; second from St. Armand to Shipton, (comprehending also the subsid double synclinal of Sutton Mountain) and continues from Shipton to Mary's, while the third ranges from the Owl's Head Mountain thro Vaudreuil-Beauce."

Anticlinals.

Synclinal forms.

Continuation of N. W. anticlinal axis.

In prosecuting the examination of the structure farther down the va of the St. Lawrence, the axis of the northwestern anticlinal, which stated above, reaches the mouth of the Boyer River, is found to Margaret Island, about fourteen miles down the St. Lawrence, and C Island two and a half miles farther in the same direction. What ma its position still farther down the river remains to be ascertained, as few islands to the northeast, which may occur in its course, have not been examined.

POTSDAM GROUP.

The rocks between these two anticlinals, in the country above the Cl dière, belong wholly to the Quebec group ; but early in the progress of investigation below this stream it became evident that another ser differing in character from those farther west, comes to the surface in of this district. These rocks have heretofore been classed with those the Quebec group, but they appear to underlie them unconformably, being in some places marked by fossils which Mr. Billings considers to of Potsdam age, they are now placed in the upper part of the Potsdam gro Described in descending order, and in general terms, these rocks are follows :

Potsdam group.

Quartz rock.

F

1. Light drab quartz rock, weathering white, with a very vitreous looking surface, sometimes becoming a gray quartzose sandstone ; both holding disseminated flakes of black and greenish shale and occasional pebbles

Ft.

of gray limestone. The mass is divided into beds varying from six inches to twenty feet, at the junctions of which there is often a layer of from a quarter of an inch to an inch which is calcareous and weathers to a grayish brown. At the base there is a thickness varying from a few feet up to seventy or eighty feet of conglomerate holding limestone pebbles, mingled with a few of white quartz, in a calcareo-arenaceous matrix; in some places the whole is interstratified with beds of black shale, generally slightly arenaceous, the shale increasing in abundance toward the base.. 600

4 c of map.

Sandstones.

4 b of map.

Gray sandstones weathering to a drab, interstratified with black and gray argillo-arenaceous shales; some of the beds are from five to six feet thick, interstratified with calcareo-arenaceous bands of from one to six inches thick, as well as lenticular layers varying from one to three feet in the thickest part; these calcareous masses weather grayish-brown. The sandstones are often conglomerate in character, with pebbles up to half an inch in diameter consisting of white quartz, white feldspar, and gray limestone. In many places there appears at the base a conglomerate with limestone pebbles and boulders in a calcareo-arenaceous matrix; the thickness of it varies from ten to fifty feet, and the enclosed masses are generally one or two pounds in weight; some of them, however, would reach half a ton.................................. 700

Limestones conglomerates and shales.

4 a of map.

Gray limestones and limestone conglomerates in beds from one to six inches thick. These beds are interstratified with black limestones and black shales, as well as with gray sandstones in beds from one to six inches thick. A *Salterella* was observed in the limestone. The conglomerates are often lenticular, the masses being from one to six inches thick and from one to ten feet long. Black nodules, some of them phosphatic, are common in the conglomerates. The thickness of these beds is about 100 feet, and they are underlaid by red, green, black and lead-gray shales, and hard arenaceo-calcareous argillites, interstratified with gray sandstones, varying in thickness from six inches to ten and even fifteen feet; some of the shales are interstratified with a few layers of gray arenaceous limestones from two to six feet in thickness, associated with the red shales. Lenticular masses of limestone conglomerate are occasionally enclosed in the gray limestones and red shales; black phosphatic nodules are disseminated in scattered patches, and a sponge of the genus *Archeocyathus* was met with in the shales.. 700

Distribution.

Boyer axis.

St. Gervais.

Livaudière.

most westerly exposure of this series is brought into position by an ion or probably a fault, which would meet the Boyer anticlinal ly near the line dividing St. Anselme from St. Henri in the seigniory on; and as the rock is at a lower horizon than any on this part of ver axis, the disturbance bringing it to the surface is perhaps, rather e Boyer, to be from this point considered the main continuation of clinal coming through Stanbridge. This most westerly exposure two miles west of the village of St. Gervais, in the fief La Martinière. k is a gray moderately coarse-grained hard sandstone; it is sup- belong to the second of the divisions given (2), and what is seen of it he eastward. In Livaudière, to the west of the village mentioned,

an exposure of quartz rock presents itself, likewise dipping to eastward; it would overlie the previous exposure, and is considered t a part of the uppermost division (1). Strips of this rock occur on road, and to the north and south sides of it, for two miles to the nc eastward, and one of the exposures, a mile from the village, and soutl the road, is associated with a conglomerate about twenty feet thick, h ing limestone pebbles in an arenaceous base. The breadth, comprehen all the exposures here, appears to be about a mile and a half.

St. Raphael.

Continuing northeastwardly, rocks of the division 1 are seen occas ally to within two miles of St. Raphael church, and again on Rivière Sud at Le Sault, which is ten miles from St. Gervais. This last loca is in the seigniory of St. Vallier, and about a mile and a quarter nort St. Raphael church. The quartz rock of the division 1 is here in

Overlap folds.

stratified with black shale, and the strata are much affected by overlap fo leaning to the northwest, which are displayed on the river banks, the hig and lower dips of the opposite sides of the folds inclining to the so

St. Pierre.

eastward. Strips of the quartz rock continue to the village of St. Pierre the seigniory of Rivière du Sud, where a considerable exposure occ About a mile and a-half southwest from St. Thomas there is an expos between the St. Pierre road and the Rivière du Sud, occupying a breadt 200 paces, with a dip S. 31° E. $<$ 30°–90°; and a mile south-east from village there are others, which spread to a breadth altogether of two an half miles. They are limited on the southeast side by the red sandsto and shales of the Sillery formation. This member of the Quebec group sk the quartz rock all the way to within three miles of St. Gervais, a tance of twenty miles, while for the remaining six miles to La Martini they are bounded by the Lauzon formation. The Lauzon bounds them also the northwest from La Martinière to within four miles of the position to wl we have arrived, but for these four miles they appear on that side to

Want of conformity.

in contact with the Sillery; this general arrangement shewing the wan conformity between the higher and lower groups.

The quartz rock makes a much more conspicuous figure below Thomas than above, and forming bold ridges and hills, it often shews la

Lepinay to Arago road.

areas of bare white rock. In this direction it passes through Lepinay, Joseph, Ste. Claire, Vincelot, the south part of l'Islet, and the north p of Lessard, as far as the Arago road. The sandstones of the succeed

Division 2.

division (2) emerge from beneath it on the northwest the whole way. Arago road, running to the southeast, starts from the coast about a r above the village of l'Islet. On this road these sandstones rise f beneath the Sillery formation, about three miles and a tenth from the co and occupy a breadth of two miles and seven tenths to the base of quartz rock, the width of the latter being two miles. The Sill

ds this on the south-east side, all the way from Lepinay, with the ption of a patch of the Lauzon, which covers part of it, and narrows and to less than half a mile on what is called the Cape road, running east from Cape St. Ignace. Cape road.

llowing up the quartz rock to the northeast, it is traceable through emaining portions of l'Islet and Lessard, and through Port Joli and nier to the Elgin road, a distance of twelve miles, flanked on its southrn outcrop by the Sillery almost all the way. The sandstones (2) i rise from beneath it on the northwest, maintain at the summit the course they exhibited above the Arago road for two miles below it, then turning more northward for about two miles, widen out considera- They are seen in several places between the Grand Trunk railway the coast, as far as the Elgin road station, before reaching which they pread out northward by undulations, and come upon the coast a short nce below the village of St. Jean. Some distance above St. Jean oast appears to be occupied chiefly by Lauzon rocks, but just at the end of the wharf at l'Islet, there occurs an exposure of sandstone iated with limestone conglomerate, which may belong to this division but whether connected with that below St. Jean by a continuous outunder the water it is difficult to say. L'Islet to Elgin road. St. Jean.

t and near St. Jean there emerges from beneath this division (2) on oast, and runs through the village, a lower series of strata, the upper of which consists of gray even bedded limestones, accompanied by lomerates with limestone pebbles in a calcareo-arenaceous paste, both em containing black phosphatic nodules, and both divided into beds of an inch to a foot in thickness, and interstratified with black shales. se belong to the summit of the next and lowest division, and are eeded, less than a mile above the village, by the following section in ending order, belonging to the same division (3):

Division 3.

	Ft.	
Reddish even bedded limestones, interstratified with red shale, the red shale becoming more abundant in the lower twenty feet.	30	
Reddish even bedded limestones, in layers of from one to eight inches thick, with lenticular patches of conglomerate holding calcareous pebbles in a calcareo-arenaceous paste, the patches being from half an inch to six inches thick, and eight feet ong	35	
Gray compact slightly calcareous argillite	4	
Red shale	5	
Red and lead-gray shale	20	
Lead-gray soft shale	24	
		118

To this, about 320 paces up the coast, succeeds the following section, which is supposed to be an immediate continuation of the last.

Gray sandstone	45	
Lead-gray shales and gray sandstones	60	

	Ft.	
Red and black shales, interstratified with gray hard calcareous argillites of from one to two inches thick.................	15	
Greenish-black shale..	8	
Black shales with gray compact layers of calcareous argillite, less abundant in the upper and lower ten feet..................	39	167
		285

Following the coast road over the sandstones (2), the limestones a black shales of 3 soon again appear, and are traceable to the coast end of t Elgin road. This road runs into the interior southeastward across t measures, and on it, after passing over some red and green shale the even bedded limestones of 3 plunge beneath the sandstones ov a mile from the margin of the river. Several minor undulations here affe the measures, and the sandstones (2) are seen crossing the road about quarter of a mile beyond the railway station. The quartz rock (1) is see on the northeast side of the road, but through the influence of undulatio it does not cross it nearer than a mile from the depot. About three quarte of a mile to the northeast of the road, the base of the sandstones an that of the quartz rock are seen within 300 yards of one another, wi

Thickness of sandstones.

a dip S. E. $< 44^\circ$. This would give to the sandstones a thickness of abo 600 feet. On the Elgin road the quartz rock occupies a breadth of mile and a-half, in a general synclinal form, with many minor undulation and the end of the trough extends to the southwest, with several toot like projections, for about a couple of miles. Farther southeast on the roa the only strata seen for three and a half miles are gray sandstones (2) but here a bold bluff occurs on the southwest, forming the extremity

Synclinal ridge of quartz rock.

a ridge, in which the outcrop of the quartz rock presents itself, turnin upon a synclinal axis. The flanks of the ridge run southwestward on on side and southward on the other. The area occupied by the quartz roc thus widens out as it proceeds to the southwest, and ultimately, by the ai of many undulations, attains a breadth of three miles, forming a high rugge and broken country.

From the distribution of the quartz rock and the sandstones, a they have thus far been described, it will be evident that we have here th extremity of a synclinal form in the quartz rock, which extends all th way to the neighborhood of St. Gervais, a distance of about fifty miles, an that the sandstones to the northwest of it, on the Elgin road, stand i the form of an anticlinal between this synclinal and another in the quart rock nearer the coast. In the run of the more southern synclinal there i no farther exhibition of quartz rock to the northeast, if we except a smal apparently outlying patch, less than a quarter of a mile long and a hundre yards wide, which crosses the Elgin road at the sixth mile-post from the fron

shford and Fournier, and sinks beneath the Sillery immediately beyond, ingly in the strike of the quartz rock farther to the southwest. This possibly have some outcrop connection with the main area of the , but there is not at present any means of proving it; and we shall efore now proceed to describe the farther distribution of the Potsdam s, as connected with the northwestern synclinal. N. W. synclinal of quartz rock.

rom the Elgin road the sandstones which bound the quartz rock his synclinal on the southeast side, run across various seigniories townships to the Lac de l'Est road, and into Woodbridge, a distance out twenty-five miles, maintaining a pretty regular course, limited all way by the Sillery formation, but gradually narrowing from six to a little than two miles. On the coast the shales of the lowest division (3) well exposed from the Elgin road to the neighborhood of St. Roch, and he beach immediately above St. Roch the even bedded limestones of 3 afforded one or two specimens of a fossil, decided by Mr. Billings to *Salterella*, about the size of *S. Macullochi* from the Lower Quartz rock cotland. Inland from this these limestones appear to alternate with sandstones either by interstratified beds of passage or by undulations, ibly by both, as far as the railroad, and a little south of it. The rocks he division 3 are again seen at the mouth of Rivière Ouelle, where e are gray calcareous sandstones interstratified with a few layers of y arenaceous limestone from two to six inches thick, associated with occaal red shales. Enclosed in the grey limestones and red shales, there short lenticular layers of limestone conglomerate, with the calcareous les of which are mingled rounded nodules, some of which are chiefly sphate of lime; and it was among such nodules as these that rred the phosphatic cylinder, mentioned in the Geology of Canada, p. , and there compared with *Serpulites*. In one of the pebbles of the glomerate was obtained a fossil form, which Mr. Billings considers to be onge of the genus *Archeocyathus*. Rocks of the same character occur ood exposures on the coast from Point Iroquois to Pointe aux Orignaux; ce to St. Denis, and northward at Cape Diable. Rounding Kamouraska they are concealed, but reappear two and a-half miles above Kamoura church, and form a ridge from a quarter to half a mile wide, as far he church; but gradually narrowing they disappear under the water a mile beyond it. Half a mile east of the church the following nding section occurs:

Lac de l'Est road.

Fossils.

Division 3.

Phosphatic nodules.

	Ft.	In.
Gray limestone conglomerate	5	0
Red shale	2	0
Gray limestone conglomerate, with black nodules in scattered patches	0	9
Gray shale with interstratified beds of compact gray limestone of from one to two inches thick	3	0
Red shale	1	6

Section near Kamouraska.

K

	F
Pinkish compact limestone with enclosed lumps of red shale.............	
Gray limestone conglomerate...	
Red shale..	
Red shale with thin layers of compact gray limestone...................	
Red shale with short lenticular layers of gray limestone conglomerate.....	
Green shale with beds of gray limestone of from two to six inches thick....	[illegible]
Red shale with layers of grey hard calcareo-argillaceous sandstone.......	

Crow Island.

The rocks on Crow Island, which lies out in the St. Lawrence a l over a mile, are greenish-gray red and black shales, the latter interst fied with a few bands of gray limestone, holding rounded black nodu which appear generally to accompany them. Burnt Island, which further out and lower down the river, was not examined, but Grand Isl which is still farther down, appears to be formed of the same measu The following section, which is in ascending order on the northeast en the island, apparently crowns an anticlinal axis :

Section, Grand Island.

	Fi
Lead-gray shales, interstratified with some black shales..................	1
Gray compact quartzite..	
Lead-gray shale, with yellow weathering calcareous nodules of a sub-cylindrical shape and from one to two inches long...............	1
Gray compact limestone..	
Lead-gray shale, interstratified with layers of black shale...............	2
Lead-gray shale, with yellow weathering calcareous sub-cylindrical nodules.	1
Lead-gray shale with thin black layers................................	
Gray brown-weathering dolomite......................................	
Lead-gray shales with black shale layers................................	5
	12

All the strata seen on the island resemble those of this section, and rocks on this and Crow Island shew a well marked cleavage, the underli which is S. 44° E. < 65°. On an island, apparently in the strike of C Island, there is a band of light gray pure limestone from ten to twenty f wide, associated with lead-gray shales resembling those of the section.

On the coast these shales and limestones (3) are not seen from the s mentioned near Kamouraska to a position some five or six miles below village of St. André. Here they run along the margin of the river in narrow strip to a point nearly two miles below the Temiscouata Port road in the seigniory of Rivière du Loup, and they appear to be overlaid the southeast by the Lévis formation, shewing some of its graptolites, a by the Lauzon beyond.

Temiscouata Portage road.

The limestones and shales of 3 again appear at the point outside the mouth of River du Loup, and they are seen on that on which the vill

Cacouna is situated, from which they extend about two miles beyond. Cacouna.
ow this they appear to be covered by the gray sandstones (2) and the
ery formation ; but they appear on the coast opposite Trois Pistoles, just Trois Pistoles.
he old church.

n following the gray sandstones (2) northeastward from the Elgin road
find them to be in all cases true to their position between the limestones
shales (3) and the quartz rock (1), as far as Trois Pistoles and
ond. The quartz rock below the same road, spreads out greatly
he coast side, a little before reaching the line between the seigniory of
Roch des Aulnais and Ste. Anne. Just west of that line, however, the St. Roch and Ste. Anne.
zon formation covers it up, except where two elevated domes of no great
a, the crowns of two small anticlinal folds, protrude through the newer
ta. The western edge of the quartz rock, farther north, through the
ct of eight similar undulations, shews nine long projecting synclinal points
ore reaching the coast some distance above Ste. Anne village.

As an example of the effect of these numerous subordinate undulations Subordinate undulations.
ay mention a synclinal in the quartz rock, which has its axis two or
ee hundred paces to the southeast of the Ste. Anne college, and is trace-
e in a general course of S. 60° W. to near the coast, five miles distant.
roughout the last two miles of this distance the breadth of the synclinal
quartz rock does not exceed 250 paces. These undulations produce many
nded isolated hills, rising on the anticlinal crests to heights of from 200 to
) feet above the plain. From the point of the long synclinal form which
just been mentioned to a position about two miles below St. André no less
n nine and twenty projections of a similar character, though less in length,
ge the general run of the quartz rock, giving it on the map the figure
great comb, while between these synclinals the quartz-shielded anticlinals
in many places like islands from the clay-covered plain, giving to the
ntry an aspect not seen anywhere else. In the neighborhood of Ste. Ste. Anne
ne are three of these mound shaped masses. One is on the north side
he railroad two and a-half miles above the Ste. Anne station. Another is
the opposite side of the road, two miles along the road, and seven-eighths
a mile to the southeast of it. This one rises to a height of 504 feet above
railroad, or 467 feet above its base. A third rises with a height of 250
t, immediately to the west of the village, giving to this, with its college
l model-farm, a very cozy and sheltered aspect.

The following section was obtained at the last named hill, and may be con-
ered a pretty correct representation, in ascending order, of the great
ss of the quartz rock (1), wherever it was seen :

Ft. n.

Gray limestone conglomerate holding pebbles of quartz and limestone, those of the latter being by far the more numerous, and varying in size from an eighth of an inch to one and two feet in diameter. The

Section of quartz rock, Ste. Anne.

	Ft.
pebbles are imbedded in a very arenaceous limestone ; on account of the *débris* and bushes at the base of the hill the thickness is somewhat uncertain	80
White quartz rock in one bed, with brown-weathering calcareous masses of irregular shapes and not sharply defined	6
White quartz rock in one bed, with calcareous masses of the same character as before, some of them three and four feet in diameter	11
White quartz rock as before, in one bed	4
White quartz rock of the same character, too much broken to determine the thickness of each bed	130
White quartz rock of the same character, in seven beds of from three to eight feet thick	50
White quartz rock, approaching in character a quartzose sandstone, in several beds	24
White quartz rock in eight beds, varying in thickness from three and a-half to thirteen feet	66
Measures concealed	12
White quartz rock, with thin lenticular patches of a calcareous character conformable with the bedding, occurring at intervals of from two to six feet, the whole forming one bed	21
White quartz rock, in two beds of three and five feet respectively	8
Brown calcareous sandstone in two beds	11
White quartz rock, without calcareous matter, in several beds	55
Gray quartzose sandstone, in one bed	10
Measures concealed, supposed to be black shale	13
Gray sandstones, partly concealed	14
Gray thin bedded sandstone	7
Black shale dipping N. 10° W. < 63°	4
Measures concealed, probably black shale	21
Black shale with interstratified gray hard arenaceous beds from one to two feet thick	31
Measures concealed, but supposed to be black shale and interstratified sandstone	15
	595

The northern edge of the quartz rock (1) leaves the coast at St. Ann and the strata are exposed, as has already been indicated, in a number ridges, many of them remarkably bold, through St. Denis and Kamourask regaining the margin of the river about two miles below Kamouras church. In consequence of the undulations the quartz rock is seen alternate with the sandstones (2) nearly all the way. They continue thence to St Anne, and about three miles below the church of that village appe to sink under the Lévis and Lauzon formations. The quartz rock is aga seen in a narrow strip which crosses the River du Loup below the Hig falls, while the sandstones associated with black shales (2) come fro beneath the quartz rock lower down the river, and are exposed to its mout Below River du Loup the sandstones are exposed almost continuously the mouth of the Green Island River, and extend along the coast still fu

High falls. River du Loup.

Green Island River.

o the mouth of the Trois Pistoles, the Potsdam rock being limited e way on the southeast by the Lauzon formation.

the south-east side of the more northern synclinal we have already ed the sandstones (2) to Woodbridge. Here trending more northward urn round the end of a synclinal promontory of quartz rock, and then ng again north-eastward they cross Woodbridge, Granville, the ing parts of l'Islet du Portage and Bungay, and reach the Pohene-ok road, where they are upwards of a mile wide, and to which they ounded on the south-east side by the Sillery. On the north-west are limited across Woodbridge by the Lauzon formation, which, more e westward, lies in a broad belt between the opposite out-crops of the al quartz rock synclinal; but across Granville and l'Islet du Portage are limited by a somewhat narrow strip of quartz rock, which there ges from beneath the Lauzon, but sinks beneath it again in Rivière du , upwards of a couple of miles from the south-west line of that sei-y.

Pohenegamook road.

e quartz rock again emerges from beneath the Lauzon a little farther Rivière du Loup, and, accompanied by the sandstones (2) on the -east, runs across the remainder of Rivière du Loup and the Temis-a road, where the line between these divisions (1 and 2) strikes near six mile post. Farther on, these divisions cross the north part of worth, the west corner of Viger, and disappear north of Fraser's mill, e Green Island River, near the line between the last township men-d, and the seigniory of Cacouna. They here sink beneath the Lauzon ation, which bounds the Potsdam rocks on both sides, from the middle vière du Loup, and thus covered up they probably form the extremity trough.

Temiscouata road.

the north-east side of the Green Island River, in the seigniory of Verte, about two miles from the south-west boundary, and eight-tenths mile from the coast, the quartz rock (1) again occurs, followed on outh-east by the gray sandstones (2) which as already stated, appear on the coast in this neighborhood, thus giving to the quartz rock a linal form, and in this arrangement it is pretty generally seen extend-o Trois Pistoles River. This is as far as the examination reached e coast, with the exception of work extending about fifteen miles to north-east, to connect the details of which, would require farther tigation.

Seigniory of Isle Verte.

addition to the *Salterella* met with in the even bedded limestones near St. Roch, the following fossils were obtained from the limestone les of the conglomerates interstratified with the quartz rock (1) and e of the sandstones (2), in procuring which I was much assisted by T. C. Weston, whose painstaking perseverance and success as a

Fossils.

collector is so well known to you. One of the localities which proved fruit in the search is about a mile north of the St. Denis station of the Gra Trunk railway. The conglomerates at the base of the quartz rock this place yielded *Salterella rugosa*, and undetermined species of *The* and *Discina*, with undescribed species of *Crania and Metoptoma*, unnamed *Agnostus*, *Olenellus Thompsoni*, *Conocephalites Thompsoni* a several other species of trilobites. From limestone pebbles of the cong merates associated with the sandstones (2), at this place, in addition *Fucoides* an *Archeocyathus* was obtained, with new species of *Discina* a *Crania*, and *Obolella desquamata*, as well as new species of *Bathyur* and *Olenellus Thompsoni*. A third and last locality is Bic Harbor ; t conglomerates from the pebbles of which the fossils were here obtained a supposed to be on the same horizon as the previous one. The fossils a *Obollella desquamata*, *Kutorga cingulata*, new species of *Discina* a *Crania*, *Salterella rugosa*, *Olenellus Thompsoni*, a new species of *Bath urus* and *B. senectus*, *Conocephalites Adamsoni* and several oth species of trilobites of undetermined genera. The whole of the foss here named have been determined by Mr. Billings.

St. Denis station.

Bic Harbor.

QUEBEC GROUP.

Quebec group.

Little more remains to be said of the divisions of the Potsdam grou and the additional localities in which they where observed will be mo conveniently connected with the description to be given of the distributi of the members of the Quebec group, many allusions to which ha already necessarily been made in what has been written above. T general characters of the rocks of the Quebec group have been so often d cribed in previous Reports that it is not considered necessary to rep them on the present occasion, and the only allusion I shall here make them is to state the fact that in proceeding north-eastward from t Chaudière the magnesian deposits of the Lauzon division gradua diminish and finally die out, and the metalliferous ores which render this division so valuable disappear with them, leaving a barren prolong tion of the more argillaceous part to represent the formation. In t prolongation the magnesian deposits are continued farther on the sou east than on the north-west, and while the general strike of the seri is to the north-east, the line limiting the magnesian and metallifero deposits trends more nearly east, at length becoming covered by the unc formable Upper Silurian series, which bounds the whole group on t south-east side.

Absence of magnesian deposits.

It has been already stated that the Bayer anticlinal axis reaches Ma

and Crane Islands, the former about fourteen miles down the St. ence. On Margaret Island, the probable base of the Lauzon forma- presents a series of glauconite shales, similar to those of the Island leans, from beneath which shales of the Lévis emerge, characterised e frequent occurrence of graptolites, most of which are obscure, but g them there were procured one or two specimens of *Phyllograptus stifolius.* These formations were again underlaid by unconformable shales interstratified with bands of hard compact calcareo-arenaceous lites, similar to those already described in divison 4 of the Potsdam s.

Glauconite shales.

Graptolites.

Crane Island, the Lévis shales with graptolites are seen on the -east side, but the main body of the island consists of the red and shales belonging to the Lauzon. On the west end of the island a of sandstone occurs, running north-westward, transverse to the gen- strike of the Quebec group measures, and probably belongs to the nformable Potsdam beneath.

Crane Island.

rosse Isle, lying to the north-west side of the Bayer and Margaret linal axis, is composed of red and green shales, alternating with green conite shales inclosing irregular masses of gray limestone, belonging, efore, to the Lauzon formation ; but on the north-east end of the island is a band of conglomerate of twenty feet thick, which, from the pre- lerance of calcareous matter, would altogether make a tolerably pure stone. The pebbles are small and consist of a compact gray lime- mixed with many small black nodules, some of them probably phos- ic. The matrix is a gray, yellow-weathering, slightly arenaceous stone. In the absence of fossils it is difficult to decide whether the belongs to the Lauzon or to one of the divisions of the Potsdam s. Its relation to the shales is not always the same over the quarter mile in which it is exposed, so that it may belong to the inferior group.

Grosse Isle.

Limestone.

n the southeast side of the Bayer anticlinal and of the Lévis beds, which ings to the surface on the Bayer River, the Lauzon presents itself, pying the coast from St. Vallier village to Berthier and a mile below. m this it runs in a narrow strip to the south-west between the Lévis the Sillery formations to La Martinière, where it rounds the end of the ry, turning under a synclinal axis, and running towards St. Thomas, pies a place between the Sillery and the Potsdam rocks, as has viously been described.

Berthier.

he synclinal belt of Sillery, whose relation to the Potsdam rocks has n already given, runs north-eastward to the vicinity of the line between seigniories of l'Islet and Port Joli. The rock then folds over an anti- al axis at the St. Ignace station of the Grand Trunk railway ; from , minor undulations carry it northward to the village of St. Ignace,

Sillery synclinal.

and it occupies the coast from this to within a mile of Berthier. T Lauzon comes from beneath it at the St. Ignace station, and this formati occupies the coast down to the position in which it has already been inc cated near St. Jean.

Sillery formation.

Of the Sillery formation nothing more is seen on the coast until reachi the neighbourhood of Cacouna, between which and the mouth of Green Isla River it occupies the coast for about eight miles, with a probable bread of about a mile and a half; but the Lauzon, as has already been indicate lies in a synclinal belt on the north-western trough of quartz rock, stretc ing sixty miles down the valley of the St. Lawrence. The south-wester end of this belt occurs near the line between the seigniories of St. Ro des Aulnais and Ste. Anne, and the rocks of the formation cross Ste. An with a very variable breadth, overlapping the Potsdam to a greater or le extent in different places. Near the River Ouelle station, at St. Pacôm they almost entirely cover up the quartz rock on its north-west out-cro while they lie in patches in their run from this towards Ste. Anne. On of these patches underlies that village, where the strata, consisting of red an green shale, with a few beds of gray limestone, are seen around the church North-eastward of the River Ouelle they are seen across St. Denis an Kamouraska seigniories. About three miles and three quarters eastwar from the St. Pascal station, in the latter seigniory, in a brook close to th railway, a few obscure graptolites were met with in black shale, with re and green shale on the north-west, and gray sandstone on the south-east.

St. Pacôme.

Ste. Anne.

Crossing Granville, exposures of the Sillery formation occur about a mil south-east from the station of St. Helène, on the line between Granvill and Islet du Portage. They here form the south-western extremity of a trough, the north-west line of which crosses the railroad about two miles below the St. Alexandre station, where the trough has a breadth of abou two miles. The Sillery trough terminates in this direction about a mil south-east of the present end of the Grand Trunk railway, at the River du Loup station. A pretty broad band of the Lauzon formation limits th trough on each side, the relations of which to the Potsdam rocks beyon have already been described.

St. Alexandre

Lauzon and Lévis.

On the north-west side the base of the Lauzon runs somewhat close to the coast, and three miles south-west from the Portage church the black shales of the Lévis appear, cropping out from beneath, and shewing, by the effect of undulations, for a breadth of nearly two miles. South-east from the church, near the top of an escarpment that runs along the coast, in beds supposed to be somewhat higher than the Lévis, columns of crinoids were observed, as well as a small *Discina*, and fragments of an *Orthis* or *Rhynchonella*, but too obscure to be specifically determined. This escarpment of Lauzon, with probably a little of the Lévis at its base,

Fossils.

prolongation to the north-east forms the precipice of the High Falls of ;iver du Loup, and overlies the quartz rock of the Potsdam below. The bution of the Lauzon farther on has already been given in describing of the Potsdam rocks, and need not be here repeated. In Villeray, small brook falling into the Green Island River on the left bank, : shales, holding disseminated nodules of iron pyrites, and pro- 7 belonging to the Lévis formation, protrude through the Lauzon on .xis of an anticlinal.

Characters of the Lauzon.

iere is a great sameness in the lithological characters of the Lauzon ghout the region examined. It consists in general of green and red s, with bands of gray quartzose sandstone becoming white by exposure e weather. These arenaceous bands seldom exceed twenty or thirty .n thickness. In some places the green shales become very arena- ;, and they are occasionally characterised by bilobated fucoids, resemb- those occurring in the sandstones of the Chazy formation on the ıville canal and at other places in the valley of the Ottawa River. ıroughout the whole distribution of the Lauzon thus far described thin s of gray arenaceous limestone are frequently interstratified with the ınd green shales. There are beds of this character, more conspicuous usual, where the fossils mentioned were found near the Portage :h, and a section met with about half-way between the Portage road :he village of River du Loup, three hundred paces north-west from second range road of the seigniory, where the strata dip S. 70° E. < –87°, may be given as an example of their greatest development. Here n feet of gray, tolerably pure limestone, with obscure bivalve shells, ıf them an *Orthis* or *Rhynchonella*, are surmounted by twenty-four feet ay, yellow-weathering, and probably magnesian limestone, with large small spots that remain gray, giving a mottled aspect to the whole. ı both sides of the River du Loup, near the railway station, there are with some moderately pure limestones, passing occasionally into lime- conglomerates. In the locality on the left side, the same obscure *is* or *Rhynchonella* as before was met with. Along the road between second and third ranges, a little north-east of the line between the seign- s of Rivière du Loup and Cacouna, there is a set of limestone con- erates, interstratified with gray calcareous argillites and red and green s, underlaid by a band of white quartzose sandstone of undetermined ness. In the matrix of the conglomerate, which is a limestone differing little in aspect from that of the pebbles, a coral was obtained, which Billings considers identical with *Stenopora fibrosa*, and an unnamed *ıis*, the same as a species that occurs in the Lévis formation. The ıreous argillites yielded an *Ophileta*, and portions of a *Lingula*, fragments of graptolites and trilobites. On one of the slabs along with fossils a few specks of green carbonate of copper were observed.

Fossils.

Second main anticlinal.

The general course of the second main anticlinal from St. Mary's the Temiscouata Portage road has been already indicated, and it n remains to describe the distribution of the Quebec group in the synclin on each side of it, between the Potsdam series on the one hand and t Upper Silurian on the other.

N. W. synclinal.

In the north-western of these synclinals the Sillery, which is the highe rock, commences in a point in Ste. Marguerite, about a mile south-we from Ste. Marguerite church. From this the formation widens out rapid to the north-east in Joliette, and in crossing the Etchemin River its bread is two miles and eight-tenths, its northern limit being a little below St Claire. On the line between Joliette and Buckland it is somewhat wide its northern limit being on the fifth and its southern on the sixteenth lo both of the first range of the township. On the St. Gervais road, Livaudière, its width is nearly four miles, its north-west edge being abo a mile north-west of St. Lazare, and its south-east on the fifteenth lot of th third range of Buckland. From this the northern base gains rapidly the north, and when it comes upon the quartz rock of the Potsdam serie about three miles north-east of St. Gervais, its breadth to the eighth rang of the Augmentation of St. Michel is ten miles.

Lauzon.

The Lauzon, coming from beneath the Sillery at the junction of th latter with the Potsdam rock, skirts this rock, as has heretofore bee stated, to its termination in La Martinière, occupying a synclinal forr which extends to a point some miles beyond the Etchemin, and lies betwee the undulation or fault bringing up the Potsdam, and a minor anticlina which carries the black shales and limestones of the Lévis formation fro St. Anselme on the Etchemin to the St. Gervais road, nearly a mile south east from the village of that name. On the south-east side of this mino anticlinal the Lauzon has a direct breadth of four miles on the Etchemi to the vicinity of Ste. Claire, and fills up the space between the river an the Sillery. Without reference to its figure in the north part of Joliett farther south-west, between the Etchemin and the Chaudiere, it crosses th former stream, and follows the undulating run of the Sillery to the term nation of this beyond Ste. Marguerite. It thence attains the Chaudière, o which it has a direct breadth of about three miles, in the form of a synclina its northern base being about a half a mile below, and its southern two an a-half miles above the village of St. Mary, the Lévis formation emerging o both sides beyond it. Between the Lévis and Sillery, on the south-easter side of the latter, it becomes reduced by undulations to a very narrow band, between Ste. Marguerite and the Etchemin, where it measures fror half to a quarter of a mile; but it widens again in Buckland, which i enters with a breadth of two and a-half miles, extending from the sixteent to the twenty-fifth lots of the first range. In this distribution of the Lauzo

ıagnesian band, which masks its base to the south-west, was represented ıncretionary rocks,holding ovoid concentric shapes, in which serpentine formed a constituent mineral. Through the influence of numerous ılations affecting the strata, these rocks sometimes occurred in unexed places, and frequently occupied considerable areas, but they were ys separated from the upper magnesian band, which marks the base of Sillery, by some amount of argillaceous deposits.

Lower magnesian band.

n the Chaudière, the Lévis connected with the second main anticlinal, breadth of about nine miles between the Lauzon of the northern synclind that of the southern, which it meets about a quarter of a mile above Joseph church. From the Chaudière the Lévis runs north-eastward ss the seigniories of St. Mary and St. Joseph to Joliette and Frampton, orth-western boundary running across the chief part of the former, a or two within its boundary, but reaching the line between the two in enth range of the township, and entering Buckland on the twenty-fifth The southern boundary, passing into Frampton on the third lot of the range, through the influence of undulations, soon gains the twentieth reducing the breadth to seven miles. Farther to the north-east, this ıdary leaves Frampton on the twenty-fourth lot of the eleventh range, sing the Etchemin on the same lot. The formation occupies ten and lf miles on the river, but its direct breadth here, across the measures, mile less.

Lévis on second anticlinal.

he Lauzon in this synclinal is about a mile wide on the Chaudière, and rs Frampton and Cranbourne with the same breadth, the north-west ıdary being on the twenty-sixth lot of the first range of the former ıship, and the south-eastern about the middle of the first range of the r. Proceeding north-eastward the band soon widens out to two and lf miles, but contracts again to somewhat less than a mile before hing the Etchemin River, its southern boundary being there between twenty-sixth and twenty-seventh lots of Frampton.

'he Sillery formation,including certain concretionary rocks, serpentines, other magnesian deposits at its base, which however belong strictly ıe summit of the Lauzon, but for convenience are joined with the ery (see Report 1866, p. 5), has a breadth of four miles on the Chaue; the south-eastern limit, where they sink below the Upper Silurian, ıg three-quarters of a mile above the line between the seigniories of Joseph and Vaudreuil-Beauce. These concretionary rocks and ›entines are traceable to Cranbourne, and they are again seen on the ıty-seventh lot of the third and fourth ranges of Frampton. They also n several hills on the right side of the Etchemin, above a great bend he river, running parallel with it to the north-east line of Cranbourne some distance into Standon; from this they cross to the left side of the

Sillery.

Upper magnesian band.

river in Ware, where Mr. McOuat observed considerable exposures them on the first, second and third lots in the sixth and seventh rang and on lot A in the eighth range of that township. Half a mile south-e from the third lot the black shales of the Upper Silurian series w observed.*

The region of country to the north-east, still to be described, is ev where wooded, and the few roads which traverse it, though they cross measures to the south-east, very nearly at right angles to the strike, are considerable intervals from one another. In going over them the limits the formations are observable in many places ; but it will be easy to und stand that of the numerous undulations which may, and probably do occ a great many must escape detection, though some may be conjectured ; a it is, therefore, only a mere general outline that can be given in the geog phical distribution of the formations.

Road S. E. from St. Raphael.

The first of these roads, which is about eight miles to the north-east St. Gervais, starts from St. Raphael, and in following it from this poi passing over the quartz rock of the Potsdam, the red and green sandston and shales of the Sillery are almost immediately seen, beginning about quarter of a mile from St. Raphael church. They are pretty well expos up the River du Sud, and through Armagh, the road gradually, by vario oblique offsets, gaining a more north-easterly position than at St. Raphae and the last exposures of the Sillery trough occur on the eighth lot of t west range of the River du Pin settlement in Armagh, which would gi to the trough a direct south-easterly breadth of a little over twelve mil with a distance of fourteen miles from the St. Gervais road near St. Lazar The Lauzon formation is supposed to occupy the next four miles of the roa the exposures, however, are not many, and those which occur consist green shales, interstratified with black bands in some places. Beyond t a distance of a mile and a-half on the road is occupied by the black shal of the Lévis formation, and these are succeeded, on the south side of t anticlinal axis, by a repetition of the Lauzon, which extends to the li between the twenty-ninth and thirtieth lots of the north-east and sout west ranges of Roux. In a farther distance of a mile and a-half the r and green sandstones of the Sillery are pretty well exposed, beyond whic after an interval of concealment, the black shales of the Upper Siluri present themselves.

Road S. E. from St. Thomas.

The next traverse that was made was on a road about fifteen miles nort east from the last, running nearly south-east from St. Thomas. On th road the Potsdam and Sillery are seen nearly in contact three and a-ha miles from the village, as has already been stated. From this the Siller

* These deposits, and their distribution in the neighbourhood of the Chaudière a described in the Geology of Canada, pp. 254 and 255.

ıpies a direct breadth of about eight miles, its south-eastern limit occur- a little farther on than the thirty-first lot of ranges A and B of Ash- on. Beyond this the Lauzon extends to the line between the second third ranges of Montminy, where it is seen on the fifteenth lot, giving ıe formation a breadth of six miles. The Lauzon formation is succeeded he black shales of the Lévis, which extend a little over seven miles to Lauzon on the other side of the anticlinal axis, the base of the forma- occurring a little beyond the line between the second and third ranges olette, on the sixth lot. To the south-east and east of this the rocks of a tolerably uniform character. They consist of green shales, with ıterstratification of a small amount of red, over a breadth of a mile and lf, and are supposed to represent the Lauzon formation. Half a mile ınd this the road turns nearly due east to the Province line. For the two and a-half miles rocks of the concretionary character already tioned as at the base of the Sillery are almost continuously exposed, at the end of the next two miles considerable masses of serpentine ır, to the west of a tributary of the Black River, from the tenth to thir- th lot of the sixth range of Talon. Nearly two miles to the east of stream a few small exposures of lead-gray slates are seen, supposed to ng to the Upper Silurian series. Serpentine.

ifteen miles to the north-east of this Government road is the Cape St. ıce road, which afforded the opportunity of the next traverse. It has ı already stated that on this road a strip of Lauzon, a little over a quar- f a mile wide, occurs, resting on the Potsdam quartz rock, near the base ıe overlying Sillery sandstones. This patch of Lauzon has but a short to the south-west; but in the opposite direction it extends a mile and a- , with the quartz rock around the end and on both sides of it, that on the h terminating in a point close to the south-west. Passing over this t of quartz rock, we meet the north-west base of the Sillery. As the was not cut through to the south-west base of the Sillery trough it not considered expedient to continue this traverse on it. The north- base of the formation was therefore examined to the Arago road, which ·ded the next traverse, about four miles to the north-east. This base ıe Sillery crosses the road about a quarter of a mile south-east from St. ille, beyond which the formation rises into considerable hills, and is well osed for six miles on the road to its southern limit. No exposures of Lauzon, however, were met with on the road to the south-eastward, ı distance of three miles farther, beyond which the road had not been ıed. Cape St. Ignace road. Arago road.

n the Elgin road nearly twenty-five miles farther to the north-east, the ery rocks have a breadth of about five and a-half miles, their north- tern limit occuring, as has already been stated, at the sixth mile-post Elgin road.

from the front of Fournier and Ashford, and their south-eastern at th between Fournier and Garneau. Few exposures, however, belongi the formation, were seen on the road, but its presence beneath was inf from the character of the country, and the occurrence of large loose lar blocks of red and green sandstone which, at intervals, almost considerable areas, quite unfitting them for agriculture. The br assigned to the Lauzon on this road is about four miles, extending t Taché road between the fifth and sixth ranges of Garneau. But exposures, however, of the formation were met with. These consiste occasional gray sandstones, and one of red and green shale seen on a br of the River Ouelle, about a mile and a-half from the northern limit. surface, however, presented the usually rolling character which belon the country underlaid by the formation, and appeared generally fit for s ment, while a short distance beyond the limit given to the formation black shales and quartzites of the Lévis became exposed. These are on the road, at intervals, for a distance of three miles and three-tenths the Taché road, which may be considered the breadth of the form here. Immediately beyond the boundary of the Lévis rocks, there occ on the north-east side of the Elgin road, an exposure, which although

Concretionary rocks.

two paces wide, was sufficient to show the existence here of concretio rocks similar to those several times already referred to ; but these must belong to the base of the Lauzon instead of its summit. After an interv concealment of somewhat over a mile, black clay slates and grayish-g sandstones prevail on the road, as far as the Province line. These considered to be of Upper Silurian age, and consequently cover up a of the Lauzon, and the whole of the Sillery, on the south-east side of second anticlinal axis.

Lac de l'Est road.

There is an intervening space of twenty miles between the Elgin and the Lac de l'Est road. It has already been stated that on this the Sillery comes upon the Potsdam rocks eleven miles from the co The breadth of the formation is here eight miles, the south-eastern e being close upon the line between the thirty-eighth and thirty-ninth of the ranges A and B of Painchaud. Beyond this the Lauzon occu a breadth of two miles ; and farther on, the rocks, although not seen, they are supposed to be Upper Silurian.

St. Pascal.

On a short excursion from St. Pascal, nearly six miles more to north-eastward than the last road, the Sillery is seen on the south-east of the River du Loup, from the above village. It is succeeded in than a couple of miles by red and green shales, with some gray limesto resembling those at River du Loup supposed to belong to the Lau formation. What breadth this band of Lauzon may have before ag meeting the Sillery farther on, I am not able to say. It is probable, h

that it is not wide, for it does not appear on the Lake Pohenegamook nearly ten miles to the north-eastward, on which the first Sillery ng on the Potsdam rocks is in the strike of the first Sillery on the St. al road, somewhere north-east of which the formation must close over rown of the Lauzon, as the red and green sandstones of the Sillery continually exposed on the Pohenegamook road, from their first arance near the Potsdam rocks, a mile north-west of the line between eigniory of Rivière du Loup and Parke, to the line between Parke and negamook, somewhat over eleven miles. Beyond this the Lauzon pies a breadth of a mile and a-half, where it becomes clearly overlaid ne Upper Silurian rocks, which are seen forming rounded hills to and nd Lake Pohenegamook Lake, as far as the Province line, and beyond. L. Pohenegamook road,

ne most easterly road on which these rocks have been examined is of the Temiscouata Portage. Here the Lauzon is seen just south- of Green Island River, and has a breadth of three and a-half miles e north-west outcrop of the Sillery, near the thirteenth-mile post, which Whitworth. The breadth of the Sillery, south-eastwardly, is a little five miles, which brings it nearly a mile south-east of the line between tworth and Armand. It is then followed by the Lauzon, which con- es to a little beyond St. Honoré, its breadth on the road being over six s, but not more than five at right angles to the measures. The rocks he formation are very much alike on both sides of the synclinal, g composed of red, green and black shales, interstratified with sional gray sandstones, while the intermediate Sillery consists of and green sandstones interstratified with red shales. The Lauzon is eeded on the road by the Lévis formation, which extends to a valley le beyond the thirty-fourth mile post, beyond which, on the east side, black clay slates of the Upper Silurian appear. Temiscouata road.

ECONOMIC MINERALS.

n the region examined the unexpected occurrence of a series of rocks r than those of the Quebec group rendered it necessary to devote a h larger amount of time than usual to the elucidation of the structure, although attention was paid, as occasion served, to the search for omic minerals, the gradual disappearance of the magnesian and alliferous deposits of the Lauzon formation, as we proceeded down the ey of the St. Lawrence, rendered our efforts unavailing. Of all the alliferous ores which appear in so many places above the Chaudière only indication observed was confined to the few specks of green car- ate of copper already mentioned as occurring a little north of the line ween the seigniories of River du Loup and Cacouna. Economic minerals.

Gold.

Although there are indications of gold in the Quebec group i Eastern Townships, the presence of the metal on the Chaudière, b the alluvium and in quartz veins, appears to be more general i country underlaid by the Upper Silurian series. Its occurrence, as as ted with this series on the Chaudière, and for some distance to the east, has been stated in various Reports since 1846 ; but as the tural examination usually stopped at the base of this series, a searc the economic minerals which may characterize the Upper Silurian farther on must be deferred to a future time. Where these rocks around Lake Pohenegamook they appeared to me to afford the most able place for an investigation of them. They are here characterize many lenticular veins of white quartz of from one to six inches in t ness, running with the stratification, and although no visible gold observed in them, and several trials of the alluvium were not rewa with success, it is quite possible that a more systematic search may the presence of the metal. The only substances of economic value I therefore, to report are bog iron ore, building stones and peat.

Bog iron ore.

Kamouraska.

Manganese.

Bog Iron Ore.—Several localities in the region examined have alr been reported in St. Vallier, (see Geology of Canada, p. 684). these I have to add two in the seigniory of Kamouraska. One of the on the north-east side of the road between the villages of Kamouraska St. Pascal, and nearly a mile from the latter, where a small de occurs at the south-east foot of a conspicuous bluff of quartz rock. extends north-eastward along the bluff for about a hundred paces, an three or four paces wide, with a thickness of from two to four inc Another deposit occurs about three miles south-west from the last, on north-west edge of a ridge of quartz rock. It is associated with wa black oxyd of manganese, as well as with yellow ochre, and is seen on road, and alongside of it, for 300 paces, with a breadth of thirty paces a depth of from six to eight inches.

Building stones.

Quartz rock.

Building Stones.—Throughout the district material for building purp is abundant. The quartz rock of the Potsdam series is well adapted such. It furnishes in many places near the railroad, all the way from Thomas to River du Loup, a fine white quartz or sandstone, which is of free from stains, and the section given at Ste. Anne, p. 128, shews t the deposit would yield blocks of any required size. It is a durable ro which is not only capable of resisting the weather, but may be conside fire-proof.

Conglomerates.

The conglomerates associated with the quartz rock are likewise v suited for building. They also are widely distributed along the line railway from St. Thomas to River du Loup, and thence along the coast Bic, where no doubt they will attract the attention of railroad contracto

xamples of the use of the rock for building, mention may be made of ailway bridges across the Rivers Ouelle and Ste. Anne. The quarries which the material of these bridges were obtained, are situated t half a mile south-east from the River Ouelle statiou.

Sandstones

he Sillery sandstones likewise afford massive beds fit for building oses. These sandstones, however, are not so conveniently situated in ect to the railroad as the rocks previously mentioned.

Peat.

eat.—Peat bogs in the seigniories of Rivière du Loup and Rivière lle have already been described in the Geology of Canada, p. 783.

Rivière du Loup.

ddition to those mentioned one occurs in the seigniory of Rivière du o, toward the south-west side, about half-way between the railway and St. Lawrence, extending about three miles in a north-easterly direction, a breadth of half a mile, and from four to eight feet deep. Another

L'Islet du Portage.

rs in the seigniory of l'Islet du Portage, about a mile south-east from Ste. Helène station. It has a north-easterly length of between one and miles, with a breadth of a quarter of a mile. Its depth in two places eight and ten feet respectively. A third locality is about six miles h-east from St. Denis station. It has a breadth of a quarter of a mile an ascertained depth of eight feet. It runs in length from the Lac l'Est road south-westerly, but how far it extends in that direction was ascertained.

I have the honor to be,

Sir,

Your most obedient servant,

J. RICHARDSON.

REPORT

OF

MR. HENRY G. VENNOR,

ADDRESSED TO

IR WILLIAM E. LOGAN, F.R.S., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

MONTREAL, May 1, 1869.

R,—Early in May of 1866 you were pleased to direct me to commence ies of explorations in the township of Madoc, in the North Riding of ngs County, Ontario, and, starting from that township as a centre, oceed to make a detailed examination of the rocks through Hastings the adjoining counties, and to take particular note of all mineral sits of economic value. The explorations then commenced were cond during the ensuing seasons of 1867–68, and I now beg to lay e you, in a somewhat condensed form, the substance of my Reports for years accompanied by a colored geological map on the scale of four to an inch.

e country examined covers an area of about 194 square miles, being led on the north by the Peterson and Mississippi road lines and the nga road; on the south by the Silurian limestones between the town- of Sheffield and Belmont; on the east by the Addington road run- through Addington County; and on the west by the Burleigh road in rboro' County. Region examined.

e townships which have been the most explored, and of which I have red a geological map, are Madoc, Marmora, Elzevir, Lake, Tudor and sthorpe, in Hastings County; Kaladar and parts of Anglesea, in Ad- on County; and Belmont and Methuen in Peterboro' County, to the of some of which allusion has already been made in former Reports. les these surveys I also made a traverse as far north as the York ch of the Madawaska River, on the Hastings road, between the Geological map,

townships of Faraday and Dungannon; on the east a survey, part chain and partly by pacing, of the Addington road, from the town Sheffield, as far north as the head of Mazinaw Lake, in the towns Abinger; and to the west a survey of the Burleigh road as far as the ship of Cardiff. These last traverses were made in connection wit central work, with a view of determining, if possible, the extent dolomites, mica-slates, conglomerates and schistose limestones of this r which, as you are aware, differ considerably in their lithological acters from the great mass of the Lower Laurentian rocks. Much mation with regard to the geology of parts of the district is found Report of Mr. Murray for 1852–53, and in that of Mr. Macfarla 1866, and the results of these explorers have greatly aided me i investigations.

Rocks of Hastings County.

Ascending section.

An ascending series of the rocks was prepared by me in 1866, an published by you in the Quarterly Journal of the Geological Soci London, for 1867, and subsequently in the Canadian Naturalist; the o at that time, being to shew the geological position of the remarkable *Eozoon Canadense*, which had been found at the summit of the se Tudor. This section, which is here repeated, was made from the resu my explorations in the townships of Elzevir, Madoc, Marmora, Bel Lake and Tudor, the average thickness of each mass having deduced from numerous exposures in the different townships. For re which will be apparent in the course of the Report it is found desira divide the section into three parts, which will be represented by di colours in the accompanying map.

Division A.

Lower division.

1. A great mass of highly crystalline syenitic rock generally deep red, but presenting varieties in texture and in color, without apparent stratification, so far as yet observed. Thickness not ascertained.
2. Reddish and flesh-coloured granitic gneiss, the thickness of which is unknown; estimated at not less than............ : ....
3. Greyish and flesh-coloured gneiss, sometimes hornblendic, passing towards the summit into a dark mica-schist, and including portions of greenish-white diorite; mean of several pretty closely agreeing measurements..
4. Crystalline limestone, sometimes magnesian, including lenticular patches of quartz, and broken and contorted layers of quartzo-feldpathic rock, rarely above a few inches in thickness. This limestone, which includes in Elzevir a one-foot bed of graphite, is sometimes very thin, but in other places attains a thickness of 750 feet; estimated as averaging.......................................

DIVISION B.*

	Feet.	
ornblendic and pyroxenic rocks, including several varieties of diorite and diabase, both massive and schistose, occasionally associated near the base, with dark micaceous schists, and also with chloritic and epidotic strata, including beds of magnetite ; average thickness....	4200	Middle division

DIVISION C.

ystalline and somewhat granular magnesian limestone, occasionally interstratified with diorites, and near the base with silicious slates and small beds of impure steatite..................................	330	Upper division.
This limestone, which is often silicious and ferruginous, is metalliferous, holding disseminated copper pyrites, blende, mispickel, and iron pyrites, the latter also sometimes in beds of two or three feet. Gold occurs in the limestone at the village of Madoc, associated with an argentiferous grey copper ore, and also in irregular veins with bitter-spar, quartz, and a carbonaceous matter at the Richardson mine in the township of Madoc.		
ay silicious or fine-grained mica-slates, with an interstratified mass of about sixty-feet of yellowish-white dolomite, divided into beds by thin layers of the mica-slate, which, as well as the dolomite, often becomes conglomerate, including rounded masses of gneiss and quartzite from one to twelve inches in diameter.................	400	
iish and grayish micaceous slate, interstratified with layers of gneiss, and and occasionally holding crystals of magnetite. The whole division weathers to a rusty brown.......................................	500	
eissoid micaceous quartzites, banded grey and white, with a few instratified beds of silicious limestones, and, like the last division, weathering rusty brown..	1900	
ey micaceous limestone, sometimes plumbaginous, becoming in its upper portion a calc-schist, but more massive towards the base, where it is interstratified with occasional layers of diorite, and layers of a rusty-weathering quartzite like 4........................	1000	
In regard to the volume thus given to this series, it may be well to remark that, though allowance has been made for numerous folds in estimating it, it may still be exaggerated by many folds that may have escaped detection.		
Total thickness..........	21130	

geographical distribution of these rocks shews a series of north-d south-west undulations, throwing the upper division (C) into long troughs in these directions. These undulations are crossed at ar intervals by geological elevations, which separate the ends of the , and by depressions which unite the sides. The anticlinal axes of th-east undulations, which are parallel to one another, and nearly t, appear, as far as ascertained, to be five in number, producing six als ; while of the transverse elevations, one runs north of west in a Undulations.

rocks of this division are described at some length in Mr. Macfarlane's Report ings Co., 1866, page 95.

somewhat curved line, and another, if it be not a final out-crop of rocks at the base, bears rather west of north. The effect of the series of undulations gives to the upper division, when laid down map, the figure of two diverging forms furnished with long proje points running in contrary directions, and precisely opposite to one anc to the contour of which the lower divisions, B and A, conform as wi seen on the accompanying geological map.

DIVISION A.

Lower division.

Perhaps the most striking and prominent feature in the towns of Madoc and Marmora is that formed by extensive barren red sye rocks, which cover a large area where the two townships adjoin. Such rc (A 1) in which there are no apparent marks of stratification, are with at both ends of Hog Lake, in Huntingdon, about two and a-half i south of Madoc village, where they are immediately overlaid by the body of the Lower Silurian limestones. On the west side of a pro tory of these limestones the syenitic rocks strike northward into Madoc Marmora, as far as the middle of the eighteenth lot on the boun between these townships, with a breadth of about four miles, the Moira forming their western limit, whence they spread eastward to third range of Madoc. This mass is known as the Huckleberry rocl Red Mountains. They are chiefly composed of flesh-red feldspar, tr lucent quartz, a little greenish hornblende, and sometimes finely diss nated crystals of specular iron and iron pyrites.

Red syenites of A 1.

All through this area the country is much broken up, and hardly able, the high barren ridges alternating with extensive swamps marly ponds. These ridges run in a northwest and southeast direction, the rock is in many parts overlaid by outlying patches of Lower Silu limestone. From the northern part of this area a subordinate eleva strikes south-eastward across the fifth, sixth and seventh concession Madoc, having a breadth of from one and a-half to three quarters of a pointing for a similar mass at Downey's rapids at the eastern end of Lake. On the seventh range it is seen to pass under an outlying patc Silurian limestone about the eighth and ninth lots, and is lost sight Several very extensive beds of magnetic iron ore, and deposits of hematite occur in the immediate vicinity of this syenitic mass in Ma and Marmora, such as the Seymour, McCallum and Marsh beds, wh will be referred to further on in division B, to which they belong.

On the outskirts of the area just described, and at its junction with overlying rocks, there occurs in many places a breccia with a granitic feldspathic base, inclosing fragments of gneiss and greenstone or dio

nagnetite, as seen a short distance south of Powell's saw-mill on the Moira, about the fourteenth lot of the tenth range of Marmora. ıer similarly brecciated, but much more strongly marked mass, in some containing rounded fragments, crosses the Hastings road about three north of Madoc village, running in a south-easterly direction down xth and part of the seventh ranges, striking with and immediately ing the Seymour iron-ore bed, and forming high and broken ridges pale red color. The enclosed fragments are greenstone, felsite, , and translucent quartz, varying in diameter from less than one inch ht or nine inches. Granitic breccia.

the north-west quarter of Madoc, between the village of Bannock- and the northeast corner of Marmora these red syenitic rocks are orming several connected parallel high ridges, called the Red Hills, ıg northeast and southwest through the influence of the undulations, axes bear in that direction. Here they are associated with albitic e, the feldspar being of a pale gray, mixed more or less with ıcent quartz and a considerable quantity of black or brownish mica ıparatively large scales. Red Hills, Madoc.

h barren hills of red syenite, known as the Red Mountains, are next ı the northwest quarter of Lake township, stretching from Tonga- ıe Lake northeastward to Clear Lake, which is situated on the twenty- and twenty-seventh lots in the eighth range of the township, the ce across being about four miles and a-half. Northeastward these ass a little beyond the town line of Wollaston. Red Mountains, Lake.

Methuen township, at the western end of Trout Lake, about two westward of the mass last described, another north-east anticlinal ıg the syenite rocks to the surface, extends from the neighbourhood of ey-bah-gah-mog Lake, which lies between the sixth and eleventh lots seventh and eighth concessions of Methuen, northeastward into the west quarter of Wollaston, forming an area commonly known as the Plains, and occupying the country for a breadth of nearly six miles, he twentieth and twenty-first lots of the first range of this township estward to South Bay on Loon Lake in Chandos. Pine Plains, Methuen.

th-westward again similar rocks were seen crossing the Burleigh nto Anstruther, but here they have not yet been traced. On Lake, between the townships of Dummer and Burleigh, similar red c rocks are seen, forming apparently the crown of a north-east and vest anticlinal. This locality has been alluded to by Mr. Murray Report of 1852-53, and the syenitic rocks here may be a continua- those of Kah-sey-bah-gah-mog Lake, but the relation has yet to be out.

se successive parallel syenitic ridges between Madoc and the Bur-

leigh road in Anstruther would appear to be brought to the surface
Transverse anticlinals. north-west transverse line of elevation. A second transverse axis st from Elzevir, and, diverging from the line already described, runs somew westward of north through Grimsthorpe, Cashel, Dungannon, Monte and Herschel townships, crossing a continuation of the same north- anticlinals as before. On this second axis of elevation, which proba
Higher rocks of A. brings up the whole of the rocks of division A, the following were som the varieties observed :

1. Coarse grained rock composed of flesh-red feldspar and translucent colorless qu the latter often in rudely parallel layers.
2. Coarse feldspathic masses, weathering to an opaque white, the constituents b white feldspar, translucent quartz and black mica in partially continuous la often determining the cleavage of the rock, which would be well suited for a able building material.
3. Dark green hornblendic rock containing a considerable proportion of dissemin grains and crystals of magnetic iron ore, and probably belonging to the ba the next division (B).

The rocks on this second line of elevation have, as yet, been but l examined. In an area extending from the neighbourhood of Que boro, on the one hand, to Mazinaw Lake in Barrie, on the other, transversely from the vicinity of Flinton in Kaladar to the north-west ner of Grimsthorpe, they appear to be very largely developed ; and probable that they will be kept at the surface in parallel ridges over north-east and south-west anticinals. It is conjectured that they occupy the western half of Anglesea and the rough and unsurveyed to ship of Effingham. Their detailed distribution through Cashel, Limer Dungannon and Mayo has yet to be determined ; but on the Hasti road cliffs of similar rock were seen crossing it about a mile north of York Branch of the Madawaska river in Dungannon, and rocks of same description were traced as far as lots nine and ten in Herschel, wh
Eagle-nest cliff. they form part of a ridge known as Eagle-nest cliff, presenting a perp dicular face of over 200 feet. The rocks on this second line of ele tion, seem, through Dungannon, Herschel, and farther north-westw to form the watershed between the tributaries of the Ottawa and those the St. Lawrence. The areas underlaid by them, as well as by th of the more south-western line, present a rough barren country, li suited for cultivation, being covered by a light sandy and often shal soil, supporting pine, hemlock and occasionally beeches, the latter usu occupying sandy ridges.

Bands of red granitic and gray hornblendic gneiss are seen associa
Crystalline limestone, A 4. with an extensive exposure of crystalline limestone, at the village Bridgewater in Elzevir, where they have been alluded to by Mr. Macfarl

Report for 1866. They become almost immediately covered up e south by the main body of the unconformable Lower Silurian lime. , and their relative position in this direction could not be made out. e rocks of sub-divisions A 2, A 3 and A 4, runs northward on the n side of A 1 along the second line of elevation, through the adjoining hips of Elzevir and Madoc, and those of Tudor and Grimsthorpe; latter two townships, however, they are only sparingly represented, gain proceeding northwestward at right angles to the northeast and west axes, in an area extending in breadth from the southeast quarter doc to the northwest quarter of Lake, and in length from Belmont to the southeast quarter of Wollaston are almost entirely wanting; position being apparently occupied by the rocks of the second divi- B) next to be described. Further to the northwest, from the north- quarter of Lake to the Burleigh road, as far as the country has been ned on each side, A 2, A 3 and A 4 assume once more an impor- haracter.

rting from Round Lake in the seventh concession of Belmont, an tant band of crystalline limestone (A 4) has been traced continuously Limestone. eastward across the lots to a position between Deer Lake and Lost where it turns northwestward to the thirty-first and thirty-second f the sixth range. It here covers a considerable area, and very resembles the white crystalline limestones of Bridgewater in Elzevir. e thirty-second lot an excavation on this band is known as Jones's e quarry, from which specimens of marble were sent to the Paris ition in 1855. From this the band has been traced northeastward the southeast quarter of Methuen into Lake, as far as the fifteenth xteenth lots of the third concession. It then runs across the sixteenth, teenth, eighteenth and nineteenth lots of the second concession, Trout Lake, but its farther distribution is not yet ascertained.

Division B.

e hornblendic and pyroxenic rocks of this division, both massive and Middle division. ose, are for the most part distributed through the counties of ngs and Addington. They are here seen to rest immediately upon neisses of A 2 and A 3, but whether conformably or not is a question be investigated, as in the localities where they are best represented, assive diorites and greenstones, which form the base of this division, t offer any clear marks of stratification.

e rocks of B are very largely represented on the second line of verse elevation, between the townships of Madoc and Elzevir, where

they have been described in some detail by Mr. Macfarlane in his rep on Hastings in 1866.

They are here much intersected by veins of a milky-white quar containing sulphurets of copper, and in some instances, as at the Ba mine in Elzevir, range II lot 5, native gold. From Elzevir, they tre northward on the western border of A, and again are seen covering a la part of Tudor and Grimsthorpe townships. To the northward on this l they are but sparingly represented. From Tudor they run westward i Lake, and are there very largely exposed along the first line of elevat of division A, and are often characterized by the presence of importa

Iron ore belt.

beds of magnetic iron ore, forming a ferriferous zone. Northwestwa from the township of Lake towards the Burleigh road, on this line of ele tion, they gradually diminish and are lost sight of, but stretch southea ward on the same line into the township of Madoc, where, however, t ferriferous band is almost their only representative.

The deposits of iron ore in Madoc, Marmora and Belmont, whi occur in the ferriferous band at the base of the greenish hornblen and pyroxenic rocks, have been alluded to in several of the ea annual reports of the survey; they have also been noticed in the Gene Report on the Geology of Canada for 1863, pp. 675 and 676, and aga

Its distribution.

in greater detail in Mr. Macfarlane's Report for 1866. In these vario Reports, however, they have been described as separate local deposits, sufficient number of facts not having then been accumulated to uni them in one continuous horizon. But having during the last three seaso in accordance with your instructions, examined them more in detail, wi relation to the rocks in which they are enclosed, I have been able to satis myself that, with one or two unimportant exceptions, nearly all the depos of magnetic oxyd in the district will be found in the present divisio being sometimes its only representative. As the deposits of iron o already known in this zone are of economic importance, and as other y undiscovered masses of a similar character may exist, I shall, with view of aiding the search for them, here give a somewhat minute descri tion of the course in which it appears to me they will be found to run.

The Seymour ore-bed is situated on the eleventh lot of the fif range of Madoc, where the associated hornblendic and pyroxenic rock and certain chloritic slates there occurring, are well displayed. The

Madoc.

course from this lot is about S. 65 E. (mag.), and passing through t tenth and ninth lots of the sixth range, and the eighth and seventh of t seventh range, along which course the ore is almost continuous, it becom partially covered up by the unconformable Lower Silurian limestone; b turning over the axis of an anticlinal, it can be traced curving throug the seventh, eighth and ninth lots, and part of the tenth in the eight

e, whence it strikes N. 65—70 W. (mag.) through the tenth, eleventh twelfth of the seventh range, and thence through the thirteenth, four-th and fifteenth of the fifth range. On the last named lot a deposit of netite occurs, perhaps next in importance only to the Seymour bed, and worthy of note that its place here is exactly opposite to this bed, and he other side of the anticlinal mentioned, on the crown of which occurs arse red syenitic rock, (A 1) which has before been referred to.

rom the seventeenth lot of the fifth range the course of the iron-bear-ocks gradually tends westerly, and would appear to pass through the nteenth and eighteenth lots of the fourth range, the eighteenth of the ., and the eighteenth and nineteenth of the second and first ranges. hese last named lots in the first range the ore is probably again in derable quantity, but the traces of it occur only in loose masses in soil, the ore in place being apparently at a considerable depth ath the surface.

om these lots the bands runs into the township of Marmora, and, Marmora. ging its direction, trends southward, keeping almost immediately to ast of the Moira River, the course of which might almost be said to te its farther run through this township. On the nineteenth and eenth lots of the eleventh range this iron zone is represented by rust-ed slates, holding some considerable beds of yellow sulphuret of iron traces of magnetic iron ore, and here it is closely associated with a mass of coarse white granular limestone. Thence it runs southward gh the tenth, ninth and eighth lots of the ninth range, where the allum iron-ore bed, mentioned in an early report, is situated; while er southward its course is indicated on the sixth and seventh lots of ighth range, by the occurrence of the Marsh ore-bed.

short distance beyond these last lots, the ferriferous belt must run the main body of the Silurian limestone lying to the south and to the where it is lost sight of. But while thus covered it appears to change ourse, and bearing westward, emerges at Marmora village, where Epidotic rocks. reen hornblendic and epidotic rocks are marked by traces of magnetic re, and hold veins of red hematite. These rocks are seen running Crow Lake, under the waters of which, and under the adjoining nformable overlying horizontal Lower Silurian limestones, the greater of the strata of this division are concealed. The north shore of the however, gives evidence of the course of the belt, in the Kean ore-which occurs on the thirteenth lot of the third range of Marmora, n an exposure protruding through the Silurian limestone on the sixth Belmont. the first range of this township. The Big ore-bed, on the south and western extremity of the lake, in Belmont, belongs to the same and is probably brought up on a third line of elevation to the west

Belmont.

Northeastward through Belmont no very large exposures of the ore ha yet been observed ; but deposits may stil be found between Crow and B mont Lakes, along the western shore of the latter, and up the valley the Crow River, as well as on Deer Lake, about the twenty-fifth, the twen sixth and twenty-seventh lots of the second and third ranges. The exposu at Allan's mills,on the twenty-fifth lot of the twelfth concession of Seymo noted by Mr. Murray in his Report for 1852-53, has probably some re tion to the turn which occurs in the course of the belt in Belmont Lal but whether united by a continuous out-crop, or separated on the oppos side of an anticlinal form, the overlying Silurian limestone prevents from deciding.

Madoc.

Returning to the Seymour bed in Madoc, with the view of tracing tl belt eastward, we find very few deposits of the ore of any extent. On t twelfth lot of the fourth range we have a small bed of magnetic iron o and again on the sixth lot of the third range, beyond which, southward, t belt runs under the Silurian. At the eastern end of Hog Lake, on t Moira River at Downey's rapids, magnetic iron ore is again met with, a finally in Elzevir, on the third lot of the fifth concession, where it occurs *Elzevir.* a bed from two to three feet thick enclosed in a steatitic material, as me tioned by Mr. Macfarlane in the Report of 1866.

Where the rocks of division B are brought up in the northwest quart of Madoc, magnetic iron ore has been found on the twenty-fifth lot the sixth range of Madoc, where a small bed occurs, dipping to the nor east at an angle of from forty to forty-five degrees. The only other local is in the extension of the belt farther north, on the fifty-fifth lot, on t *Tudor.* west side of the Hastings road, in Tudor, where it is associated w gneiss and granular limestone. (A 3 and A 4). This last locality has n been mentioned in any of the previous published annual reports, but sampl of the ore were sent by you to the London Industrial Exhibition of 186 The ore would appear to be of excellent quality, although more or le mixed with graphite. The breadth of this bed could not be determine owing to the wood-covered condition of the country, but from the lar masses of ore scattered about in the vicinity there is little doubt that occurs in abundance.

It is probable that other beds of this ore will yet be found along t course of the rocks B, whose distribution has thus far been partia pointed out, and will be farther understood from the description to given of the distribution of the next overlying division (C), at the base which this ferriferous belt occurs. Rocks similar to B were again se *Kaladar.* largely developed in the vicinity of Flinton, in Kaladar township, wher they are on the eastern border of the second transverse line of elevatio which brings up division A. They here stretch with an apparent thickne

000 feet, northeastward along the Addington road, between Barrie Anglesea, to Mazinaw Lake in the former township. Along the they are intersected by numerous reticulating veins of a pistachio-n epidote, which divide the mass into rhomboidal forms, and altogether a strong likeness to the description given in the Geology of Canada, milar diorites and slates in the Huronian system. In Addington they also followed by a green slaty conglomerate, which at present is posed to belong to the base of the next and highest division. Epidotic diorites.

Division C.

he limestones, mica-schists and calc-schists of this division are spread very irregular manner over the country examined. As stated on 146, they may be said to form two series of troughs running north- and southwest, more or less connected with each other at their sides wo transverse depressions of the strata, and separated in the middle transverse elevation. Upper division.

he number of these synclinal forms is five, with an average breadth of een four or five miles each. The most southeastern one is so obscured he interference of the overlying unconformable Lower Silurian lime-e that little more can be said of it than that its axis may be considered ccur somewhere near Queensboro', in the southeast quarter of Madoc. axis of the second synclinal runs through the southwest and heast corners of Marmora, and through the northwest quarter of nsthorpe. In this form the upper division has a length of about nty-four miles from Crow Lake northeastward, and is divided into parts of nearly equal length, which are separated from one another t a mile and a-half at the northwestern extremity of the Red Hills. The of the third would pass through the united corners of Belmont and e and the centre of Cashel. In it the upper division stretches for t thirty miles northeast from Belmont Lake, and is separated, as in last, into two nearly equal portions about a mile and a-half apart on ver Creek, about two miles below the bridge on the Hastings road. synclinal is affected by minor northeast undulations, sufficiently pro-ent to divide it longitudinally into several subordinate forms. The fourth runs through the adjoining corners of Methuen and Wollaston, and ss the middle of the south line of Dungannon. In it the rocks of the er division have an extent of fifteen miles southwestward to Eagle e, where the summit of the underlying division B appears, but what ration there may be between this and a basin on the same axis farther ne southwest, has not been clearly made out. The axis of the fifth

Five synclinals. Second basin. Third basin. Fourth basin.

Fifth basin. synclinal runs through the adjoining corners of Burleigh and Chandos, those of Dungannon and Carlow. The rocks of the upper division in extend from the York Branch of the Madawaska River, for about thirty m to the south-western end of Loon Lake in Chandos. This form is, like the others, probably divided into two parts by the out-crop of rocks the lower divisions (A and B) somewhere in the northwest quarter Wollaston.

The different rock masses which fill these troughs, have already b given in the general section, and I shall now proceed to give some local details in regard to their distribution, beginning with the lowest, (C

Limestones, C 1. At the base of the third division we have in many places large exposu of crystalline limestone, associated with dolomite. A white crystalline li stone of this horizon is very largely represented in the first synclinal Elzevir, at the village of Bridgewater, and it has there been quarried building purposes and used in Belleville. Westward from this the sa band covers a large part of the fourteenth lot of the fourteenth rang Huntingdon, on the shore of Hog Lake, where it has been worked, would appear suitable for constructions. It is, however, on this lot m more interstratified with white quartz, tremolite, and an impure talc-sl all of them in thin layers, and it holds a bed of translucent quartz feet thick. The layers of tremolite weather out in relief from the sur of the limestone and give a ribanded appearance to the rock. On lot, near the shore of the lake, there is a considerable exposure of flesh-red somewhat magnesian limestone, weathering to a yellowish-d

Dolomites. together with a brown-weathering dolomite cut by minute seams magnetic oxyd of iron, which weather out into sharp edges on the surf The flesh-red limestone, being of a compact texture, appears well sui for ornamental purposes; but both it and the dolomite are more or l micaceous, and often much interstratified with greenish dioritic sla From this lot these bands run into Hog Lake, but are again seen ab the middle of it, forming a large part of the Bridge Island.

Immediately to the east of the village of Madoc, bluish and blu gray banded crystalline limestone belonging to this horizon (C 1) adjo a drab or brownish-yellow dolomite. The limestone is more micaceous th in the previous locality, and the mica, being in continuous layers, at irregu distances through the mass, in most instances indicates the bedding of rock. This limestone has been worked and used in Belleville, but does furnish a very good building stone.

On the seventeenth lot of the sixth concession of Madoc, at and arou the Desperado mine, in the vicinity of El Dorado, a beautiful compact p flesh-red very silicious dolomite occurs, and extends east and west i the neighboring lots. On the eighteenth lot of the fifth range, on wh

ıated the Richardson gold mine, the dolomite forms prominent ridges interstratified with silicious slates.

ı the line between the first and second synclinal, in the twenty-fifth wenty-sixth lots of the sixth and seventh ranges, is a limestone of a ı-white, which would appear well suited for building purposes; but enings have yet been made on it in this locality. Limestone.

llowish-drab dolomites of a compact texture are seen on the east side Hastings road, in the twenty-second, twenty-third and twenty-fourth f the sixth range of Madoc, whence they strike in a northwesterly tion into the township of Lake.

the road running between the seventh and eight ranges of Madoc, in urteenth and fifteenth lots, ridges of a beautiful pinkish-white dolomite . It is of a rather compact texture, and appears to be very silicious, ng much fine white sand in weathering. Veins of white translucent z cut this mass in many directions, holding occasional traces of copper es.

the south-east side of the second synclinal, on the sixteenth lot of the ıth range of Marmora, and extending into Madoc, there occurs a area of white granular limestone which, when examined in 1866, eing quarried by a marble-cutter named Feigel. This marble seemed rk well, judging from the finished samples shewn me, and might ed for ornamental purposes. In accordance with your instructions es of this stone were prepared and forwarded to the Paris Exhibition 67. Marble.

the third synclinal, at the south-western end of the north-eastern n, a very fine grained white limestone was met with on the fifty-fifth est side of the Hastings road, in Tudor, immediately adjoining the etic iron ore alluded to when describing the distribution of the ferri- belt.

erlying the limestones and dolomites (C 1) of this part of the upper on there occurs a series of mica-slates (C 2) grayish and sometimes ish in color. Lighter and darker shades among these appear to be o varying proportions of mica and in some cases of hornblende. limestones and dolomites (C 1) appear to be wanting in some , and in this case the mica-slates (C 2) rest upon the rocks of division It is then also somewhat difficult to define the line of separation en the two, particularly when the micaslates assume a greenish and the limit has, in such cases, to be somewhat arbitrarily ed. Mica-slates, C 2.

mica-slates of sub-divisions C 2 and C 3, are extensively developed south-eastern side of the first or Madoc synclinal, where they have described, together with the rocks of division B, by Mr. Macfarlane

Mica-slates. in his Report for 1866. From Madoc they pass into the second synclin and in it are seen along the southern half of the eastern side of Tudor, a the western of Grimsthorpe.

In their course along the north-west side of the synclinal, these slates a

Bannockburn. seen through the eastern portion of Lake, and southward to Bannockbu village, in Madoc township, in which last locality the rusty-weatheri quartzites of the following sub-division, C 4, make their appearance, a together with the rusty mica-slates of C 3 predominate, almost to t exclusion of C 2. From thence they were traced southward, as far Keller's bridge over the Moira river, on the Hastings road, where th were overlaid by a patch of the Lower Silurian limestones.

In Marmora, in the southern portion of this second synclinal, the sla of C 2 and C 3 are seen covering a considerable area on its north-weste side, from the north-east quarter of that township to the foot or southe extremity of Belmont lake, in Belmont township; and thence along t south-eastern side of the same synclinal through Crow lake, in Marmo beyond which they are concealed by the overlying Lower Silurian lin stones.

In the third synclinal, namely that passing though Belmont and La townships, these slates are very largely represented in its southern part; th are seen along its north-western side through the south-east quarter Methuen and the southwest of Lake, and form prominent ridges near t bridge over Deer river, in the twelfth and thirteenth lots of the third ran of Lake township. In the last locality they strike nearly north, with a d to the eastward of somewhat less than thirty degrees, and are here se to rest upon the gneisses of division A.

Further on in their course, these slates reach Burnt lake, which oc pies the seventeenth and eighteenth lots of the seventh, and the grea parts of the same numbered lots of the sixth range, where islands compos of these slates mark the run of the band through the lake, and belong the northern extremity of the southern portion of the third synclinal.

At the south-western end of the northern portion of the same synclin slates of divisions C 2 and C 3 are seen to spread over a considerable ar in the vicinity of Dickey and Clear lakes, where the prevailing color of t rocks is gray. On the southeastern side of this part of the synclin these slates from the chief rock on the east side of Wadsworth lal situated in the north-east corner of Tudor, whence they run into Cash with a steep dip to the north-west. On the north-western side of t third synclinal these slates of divisions C 2 and C 3 are but sparing represented, and continue to be so in the two remaining synclinals to t north-westward.

In the first or Madoc synclinal, at its southern extremity, on the far

O'Hara and McKenzie, lots three, four and five of the fifth range, the ies of C 2 are bluish, fine grained, and somewhat argillaceous, but with leavage however parallel with the stratification. These have been newhat extensively quarried, and cut for whetstones, and are referred n the Geology of Canada, pp. 66, 809. Further specimens of these ies were procured by myself during 1866, samples of which, cut and pared in Montreal by an experienced person, were pronounced to be y suitable for whetstones. This variety has not yet been met with in of the other synclinals to the northward. Whetstones.

In different parts of the vertical thickness of the slates of C 2 and C 3, l in many places in their distribution, occur three different descriptions conglomerate, all of which are seen on the lots just mentioned, where y occur in the following order, ascending:

. A dolomite much interstratified with dark silicious mica-slates, both often holding large and well-rounded masses of quartz and syenite, which vary in diameter from one to twelve inches. Conglomerates.

I. A black and very silicious slate holding large boulders of gneiss and syenite, and forming smooth rounded dome-like ridges.

II. A grayish and sometimes greenish mica-slate, having small flat ovoid pebbles of vitreous quartz lying on their sides in the planes of bedding.

It may be remarked that while the last conglomerate is the highest the series, it is also the most continuous of the three; the other two rser conglomerates appear to occur in lenticular patches of a more al character. At the village of Bridgewater conglomerate layers und in a band of mica-schist 120 feet thick, having a streaked sure from the alternation of grayish and reddish layers. The enclosed bbles are of red and white quartz, occurring in parallel beds from two hes to five feet in thickness, which are separated by mica-schist layers ding only a few scattered pebbles.

Westward from this a similar band of conglomerate is seen on the th side of the road leading from Bridgewater to Madoc, on the third of the eighth and ninth ranges of Elzevir, which appears to me to be a ntinuation of that of Bridgewater. Here, however, it is associated with of the coarser conglomerate bands (II) rising in large rounded ridges m the field. The matrix appears to be chiefly a black silicious slate, l it is more or less charged with well-rounded fragments of quartz and enite. Adjoining this, but below it, there occurs a conglomerate with a istose dolomitic matrix, the pebbles themselves sometimes being of lomite, interstratified with similar black silicious slates. In some places rounded fragments once enclosed have been removed from the exterior, ing to the surface of the mass a pitted and cellular appearance. Where ese rounded masses are enclosed in the greatest abundance they lie in

the form of parallel beds or lenticular patches, the portion between the beds holding only a few scattered pebbles.

These conglomerates in the first synclinal are lost sight of for sor distance under the horizontal Silurian limestones, but are again se immediately to the north of the village of Madoc, forming a conglomera ridge described in the Geology of Canada, p. 32. The matrix of this a mica-slate more or less charged with grains of a dark green steati mineral. The enclosed fragments are in general rather angular, and white and black colors. Similar conglomerates occur on the third, four and fifth lots of the fifth range of Madoc, where they are on the nort western side of the first or Madoc synclinal.

In the third synclinal, on the north-west side, conglomerates are se associated with slates, and forming several islands, running with the strik on Belmont Lake, where they have already been described in Mr. Murray Report for 1852-3. They dip to the east or south of east, and are simil in character to those above mentioned.

The lower members of the upper division, thus far described, (C 1, C and C 3) constitute, in their distribution, the rim of the two sets of troug into which the five synclinals of the district have been divided. T centres of these troughs are filled with the calcareous and quartzose be which correspond to the higher members of the upper division. Lat observations make it probable that the thickness of 1900 feet assigned Madoc to the quartzites C 4, is an exageration, since in the second and thi synclinals these quartzites are much less conspicuous, and cannot be d tinguished from certain quartzose beds which appear to be interstratifi

Division C 5.

with the calcareous strata of C 5. This subdivision presents many varieti of rock, some of which are repeated several times in the vertical thickne The strata, however, are corrugated by numerous minor undulations, whi often give repetitions of the variety of a special horizon, on a given li of section. It hence becomes impossible to give the sequence of the varieties, which I shall therefore describe in the order of their importan as seen in the township of Tudor, where they are as follows :—

Varieties of C 5.

1. Gray micaceous limestones or calcareous mica schists, somewhat plumbagino with *Eozoon Canadense.*
2. White and bluish-gray compact limestone, slightly silicious.
3. Grayish quartzite weathering to whitish and yellowish-brown, and shewing th colors in alternate bands on weathered surfaces.
4. Gray impure sandy limestones with a pitted weather-worn surface, streaked spotted with ferruginous stains.
5. Gray impure limestone, similar to the last, but in addition holding radiat concretionary forms of a greenish-black hornblende, the latter weather out in rusty sub-globular masses, which are scattered irregularly thro the rock, and vary in size from one quarter of an inch to one inch diameter. This band seldom exceeds six feet in thickness.
6. Small interstratified bands of diorite or diabase, chiefly seen towards the base of sub-division C 5.

Their distribution has been sufficiently pointed out in describing the ates C 2 and C 3, which, as before stated, form the rim of the troughs cupied by the higher rocks. It should be mentioned, however, that in ssing north-ward from the second to the fifth synclinal, in Hastings, e slates and limestones of the subdivisions C 2—C 5, gradually diminish amount, and only the beds of C 1 are observed in the fifth synclinal.

The schistose and plumbaginous limestones of C 5 are characterized by e occurence of the fossil rhizopod described by Dr. Dawson under the me *Eozoon Canadense*. Unlike the specimens of this fossil found in the ystalline Laurentian limestones at several localities on the Ottawa, in iich the calcareous skeleton is generally filled with serpentine or some lated silicated mineral, the Eozoon from this region is imbedded in an pure earthy dark gray limestone ,with which and with carbonaceous atter, the cavities in the white calcareous skeleton are filled. Fragments Eozoon from this sub-division, were first detected by Dr. Dawson from an known locality in Madoc, but numerous specimens of the fossil have ice been found on the fifteenth lot of the range east of the Hastings ad, in Tudor. The specimens from this region like those from the lumet on the Ottawa, are small isolated imbedded masses, unconnected parently with any continuous reef such as exists at Grenville and e Petite Nation. Eozoon Canadense.

Specimens of the Eozoon from Tudor and Madoc have been described d figured in a series of papers read before the Geological Society of ndon, by yourself and Drs. Dawson and Carpenter ; published in the *uar. Jour. Geol. Society* of London, for August, 1867, and reprinted the *Canadian Naturalist*, vol. iii, No. 4.

In conclusion, I would state that, with a view of determining the rther spread of the rocks of division C, explorations were carried on rthward from the York branch of the Madawaska river, between the wnships of Monteagle and Herschel, as far as the Peterson road ; ence eastward along that road through Wicklow, Bangor, Radcliffe and rudenel, to the Opeonga road ; and south-eastward through Sebastopol d Grattan to Renfrew village on the Bonnechère river, but without discovering a repetition of these higher rocks. The whole tract of country us explored is composed of rocks similar to those of division A of the neral section.

Lower Silurian Limestones.

To the north of the great area of Lower Silurian limestones of the renton group, whose limit was described by Mr. Murray in his Report r 1852–3, we find isolated, or island-like patches of these limestones for

Silurian limestones.

some distance northward in the townships of Madoc and Marmora, a often separated by some miles of country occupied by the older rock One of these patches of limestone, about one mile in length by one-ha in breadth, occurs as far north as lots five, six and seven on the li between the townships of Lake and Methuen, ten miles distant from t boundary of the main Silurian area, where it forms a tract of good la known as the Van Senkler settlement.

Through Madoc and Marmora there occur similar but more extensi areas of these limestones, which are shown on the map accompanying t present Report, and were described by Mr. Murray in his Report alrea cited. These Silurian islands almost invariably present a precipitous fr to the north, the strata dipping at a very slight angle southward, a gradually becoming covered by a deep soil, their ruins stretching beyond the limit of the limestones themselves, and forming rich and fert areas. Throughout Madoc the chief settlements are in the vicinity these limestone islands, and are often separated from one another by tra of land, barren and unfit for cultivation.

Where these limestone have been denuded, their surface is seen cove by numerous grooves or markings, the general trend of which is fr 3° to 6° east of north, the same strike being also observed in groo upon an exposure of red syenite crossing the Hastings road to the north the village of Madoc.

Economic Minerals.

The economic minerals of the district under examination, as known to 1866, were the ores of iron, lead, copper and antimony, with wh stones, lithographic stone, building stones and limestones, to which now to be added ores of bismuth and silver, and also native gold.

Magnetic and Hematitic iron ores.—The ores of iron, both magnetic hematitic, occurring in Hastings county have been mentioned in severa the Annual Reports, as well as in the Geology of Canada, and having b one of the special subjects of Mr. Macfarlane's Report so recently as 18 I have little to add to what has heretofore been said about them.* T

Magnetic iron ore.

distribution of the ferriferous band, in which all the magnetic ores contained, is no doubt a matter of economic value, but this, as far as I h been able to trace it, has been given in that part of the Report which devoted to geological structure, page 150. All that I have to state theref

* In giving the localities of iron ores in that report the two following typograph errors occur: page 100, 9th line from the bottom, "*the ninth lot of range six*," shoul "*the sixth lot of range nine*,": page 102, 16th line from the bottom, "Madoc" shoul "Marmora."

ill be little more than a few facts respecting new openings in the Big ore ed of magnetic oxyd on Crow Lake.

Although the lower part of this ore bed had been previously tried, little of at part had been excavated. In 1867 a company, composed of gentle-en from the United States, was established for the purpose of working ore om the bed, with a view to its being smelted. After trials of several rts of the band that near the base was found to be of suitable purity, and ring that year 300 men were employed in mining and sorting the ore, of hich, towards the end of the season, 150 tons a-day were being carried vay from the locality by rail, and shipped at Cobourg. A few hundred rds south-east from the main work another excavation was made upon hat is called the Sand-pit bed, supposed to be still in the band, from hich a purer ore was obtained. The ore from both excavations was rted into three qualities, of which Nos. 1 and 2 were selected for exporta-on, while No. 3 was left on the ground for future disposal. Belmont.

In Mr. Macfarlane's Report for 1866 mention is made of the specular e of iron occurring on the second lot of the fourth range of Elzevir. This posit was opened during my stay in Bridgewater in 1867, but the ore as not found to exist in remunerative quantity. Mr. Macfarlane makes ention of the occurrence of hematite in a ploughed field, in and around depression on the east half of the twelfth lot of the fifth range of Madoc, here the appearances were such that, although assured no mining had en done there within the memory of the oldest inhabitant, he could not sist thinking that the depression was all that remained of an open work om which much ore had possibly been raised and removed. This lot, understand, is the property of Messrs. T. C. Wallbridge & Brothers ; but r. D. L. Cumming informed me that the lot was cleared of its timber by m in 1831, when there were but thirty families in the township. He sured me also that the depression existed then as it does now, while the ees of the forest were still growing in and around it ; that he was the first rson to see and report the occurrence of this apparently rich deposit of matite, and that since then eight tons extracted by him, and sent to iree Rivers to be smelted, was the whole quantity of the ore that had en removed from the place. Hematite. Madoc.

The ore appears to occur in loose masses, ranging in weight from one to a ndred pounds, and there seem to be no boulders of other rocks mingled ith them. I was informed, however, that a large pair of antlers of some ecies of deer had been found imbedded in the ferruginous soil. Not only is but other deposits of hematite in Madoc and the neighboring town-ip appear to occur in depressions in the gneiss, filled with loose masses the ore, the geological horizon of which seems as yet to be very uncertain.

Veins of specular hematitic ore are found cutting the chloritic slates of

the ferriferous belt, as along the west side of Belmont Lake, and r particularly on the eighth lot of the fifth concession of Belmont towns The ore in these veins, however, is but of minor importance.

Galena.

Galena.—Most of the localities known as affording galena have l noticed in Mr. Macfarlane's Report for 1866, but during my explorat in Tudor, having visited all the lead-bearing lodes, openings were fo to have been made in some of which the localities only had been previo indicated, and one or two were in a better condition for inspection tha the time of Mr. Macfarlane's visit.

Tudor.

One of these, on the twenty-eighth lot of range B in Tudor is a ver vein running N. 70° W*., the strata of calc-schist dipping 274° > 76°. the time of Mr. Macfarlane's visit a shaft, which had been sunk on the depth of thirty-seven feet, was half full of water, preventing him f doing more than to state the information he had received from oth In 1867, I found that the lode, of which the veinstone is barytes and c spar, had yielded on the average three quarters of an inch of galena ; the bottom of the shaft showed no more than half an inch of barytes, witl galena. I was informed by Mr. W. Kesterman, of Belleville, then su intending the mine, that there had been extracted from the vein a six tons of galena, four and a-quarter tons of which were sent to l York for sale, after being simply crushed, and found to yield 66 per of lead.

On the thirty-first and thirty-second lots of the range east of the H ings road, in Tudor, a lead-bearing vein runs in a vertical attitude 57° W., cutting the gray calc-schists with strike N. E. E. In 1 it had been traced, in the direction given, across both the lots mentio with very good surface indications, and was known as the Murphy m The Hastings Lead-mining Company subsequently sunk a shaft on it, wh I understand, has been carried down to a depth of 125 feet, but the re being unsatisfactory, the work was abandoned.

On the twenty-eighth and twenty-ninth lots of the fourteenth rang Tudor there is a vein of red and white heavy-spar, holding galena, and c ing the gray calc-schists. Its bearing is N. 5° E., and it stands in a vert attitude, while the enclosing rock, also vertical, strikes almost due n and south. It was discovered some eight years ago, and was first ope in 1859. In 1867 the mine was leased by Messrs. Lombard & Co. Boston, who were working it at the time of my exploration in Tudor, ar had an opportunity of examining the shaft when free from water. walls were regular and well defined, the width between them being some parts from eighteen inches to two feet, and the ore appeared scattered and irregular bunches in the gangue. When first opened

* The bearings in these descriptions are magnetic, the variation at Madoc being 5° W

ein yielded some large masses of ore, but, as in a previously mentioned stance, they greatly diminished, descending, and at the bottom of the aft, which was twenty-five feet deep, there was scarcely any ore. In 1868, the depth of forty-two feet, the mine was abandoned. It may be marked that many of these veins in Tudor, yielding considerable unches of ore near the surface, shew little more than traces of galena at e depth of a few feet. Of twenty-five localities in Tudor in which galna was discovered and partially worked, but one, the Murphy mine, conued to be worked in 1868.

The west half of the tenth lot of the eleventh range of Lake is another Lake. the localities mentioned by Mr. Macfarlane. On this lot, which was me time since bought by Messrs. Gillum & Kesterman of Belleville, curs the Donahue vein, striking N. 50° W., and standing in a vertical titude. Little however has here been done, and although the lode has width in some parts of from twenty to twenty-four inches, bounded by gular walls of gray calc-schist, the galena occurs only in scattered and regular patches and inconsiderable quantity.

On the eighth lot of the eleventh range of Lake (or possibly in the tenth nge) a vertical vein, holding galena in a gangue of heavy-spar, runs rough the calc-schists in the direction N. 45°—50° W. The lode varies thickness from ten to eighteen inches, and is bounded by well defined alls. Little had been done on this lot up to 1867, but in the short stance then uncovered, I saw extracted some masses of ore at the depth of ree feet from the surface, which weighed from fifteen to forty pounds, d I was informed that when first discovered much larger masses had en taken from the vein. The lode is supposed to be on the property of r. Wm. Sweeny of Tudor, but in consequence of the defective manner which the township has been surveyed there at present exists a dispute to the ownership of the lot.

The lead-bearing veins just noted I believe to be the most important in dor and Lake, so far as examined. In these townships there appear to be o distinct sets of these veins; one of them running north-west, and the Two sets of veins. her north-east by north, those in the former direction being the more merous. Where such veins cross one another there appears in general fair show of ore at the surface, which, however, as in other cases, often minishes at the depth of a few feet.

There occurs a north-west and south-east lode near the south-east corner Methuen, where, in 1868, a shaft was being sunk by Messrs. Parker & Methuen. ker. On this lode two or more shafts have been opened on the eastern ge of the second lot of the first range, close to the boundary line of Lake. e lode cuts gray vertical calc-schist, striking N. 20° E., and is composed calcspar and heavy spar, the former being of a rose or flesh-red color, in

which there is a good shew of galena. The average width of the lod about eighteen inches, and it has been traced in a south-easterly direct for nearly three miles into Marmora.

All of the lodes above mentioned, as well as all those noticed by M Macfarlane in his Report of 1866, intersect the calc-schists (C 5) ; but i not to be supposed that this is the only rock in which they occur, as has been shewn that in parts of the country to the east, lead veins paral to those of Hastings, and no doubt of the same system, cut not only t gneisses and crystalline limestones corresponding to division A (as example the Frontenac mine described below,) but run up into the unc formable Lower Silurian, as far at least as the Calciferous formation. It not surprising, therefore, to find on the eighteenth lot of the first range

Elzevir.

Elzevir a lead-bearing lode running N. E., and intersecting the diorit of the middle division (B). The gangue of this lode consists of quar which, in a breadth of three feet, exposed in an opening which h been made, appeared to be much mixed with fragments of wall roc The galena is scattered through the gangue in small, irregular b somewhat abundant bunches, in which the crystals are smaller th is usual in the lodes of other parts of the district. At the tir of my visit, which was not long after the discovery of the lode, b a small quantity of ore had been taken out. On the authority assays made by Dr. Girdwood of Montreal, and Mr. J. T. Bell Belleville, the galena is said to hold a considerable but variable quantity silver.

Frontenac Lead Mine.—In connection with my examinations of the lea deposits of the Hastings region I visited the Frontenac mine in the rear Kingston. The mine is situated on the south half of lot sixteen in th

Loughborough.

ninth concession of Loughborough. The rock of the country consists grayish and reddish gneiss, interstratified with thick bands of crystalli limestone, all striking N. N. E. and S. S. W., and dipping to the westward a high angle. The vein cuts these various bands at right angles, having course about N. 75° W., or N. 70° W. (mag). The portion worked has slight underlie to the north, at the surface, but becomes vertical at a dept of sixty feet in the main shaft.

Frontenac Lead mine.

From this shaft an adit has been run about 400 feet west and 50 fee east. The average width of the vein appears to be about ten feet, althoug at the main shaft it varies from thirteen to nineteen feet. The veinstone which consists of calcspar only, is arranged in bands, more or less coarsel crystalline, and sometimes of a purplish or lilac color. The only othe minerals observed were very small quantities of iron and copper pyrites an blende. The galena is diffused in crystals and bunches throughout th whole vein, but appears to be most abundant towards the north wall. I

o appeared to have a disposition to run in *shoots*, having a western slope about 45°. Between one and two thousand tons of ore had been mined. is had been sampled and portions of it assayed mechanically by Dr. wson, Professor Chapman and others, the mean of whose results gave m 12 to 15 per cent. of galena. A crushing mill, with washing machiry, and a smelting furnace have been erected. A quantity of the dressed ore has been crushed in this mill, and about five per cent. of lena obtained from the whole, but the work appears to have been very perfectly performed. The pig lead produced is of an excellent quality. ofessor Chapman's assays shew that it contains an average of about four nces of silver to the ton of galena.

The vein may be traced by a series of dry depressions in the surface, sink-holes, almost continuously for a distance of one mile to the stward, the breadth somewhat diminishing, but the vein has still the same aracters, and is in some parts rich in galena. On the eighteenth lot in the hth concession a second vein runs parallel to the first, at a distance of out one hundred yards to the north of it. This second vein appears to from three to six feet in width, and shews galena wherever it has been ened. It carries also a little barytes, which has not been found in the in vein. Smaller parallel lead-bearing veins have been discovered on adjoining lots to the north. The main vein is reported to have been t with (still carrying galena) on one of the lots west of that on which it worked.

Gold.—In the early part of August, 1866, while exploring in the neighhood of Bannockburn village, in the township of Madoc, I was informed t a metal, suspected to be gold, had just been taken from an opening in Gold. eighteenth lot of the fifth range of the township, on the property of Mr. Richardson. A visit was at once made to the locality, and the lot was nd to be the same as that on which openings had previously been made copper ore, described in Mr. Macfarlane's Report of 1866, (p. 106.) . Richardson informed me that a person named Powell, and an old tch miner, had lately found flakes of yellow metal resembling copper, ich he could beat out into thin leaves. At my request he shewed me specimens which he had collected, and I at once informed him that metal was gold.

The opening from which it had been taken was on the east end of the , the copper veins being near the south-west corner; and in it an irregu- layer of chloritic and epidotic gneiss was overlaid by a silicious ruginous dolomite, and underlaid by a band resembling an impure steatite, whole dipping N. 5° E. $<$ 45°. The seat of the gold appeared to be a vice of longitudinal ovoid form, about four feet below the surface, which s filled with reddish-brown ferruginous earth, in which were scattered

fragments of a black carbonaceous matter, the latter shewing, when bro small flakes or scales of the metal. The crevice seemed to be in the sc at its junction with the dolomite, and presented an attitude conform with the stratification. This I believe to have been the earliest discover the metal, and samples were procured and sent to the Geological Su office long before any reports were generally circulated as to its exist in the township. Having remained in the vicinity of the opening for a days while some fresh blasts were made, and seeing no farther deve ment of the precious metal, my general exploration was continued.

Richardson mine.

Early in October, however, information was brought to me that far discoveries of gold had been made on the Richardson lot, and returnin found that at the depth of fifteen feet another open crevice had been str which, beyond doubt, had proved rich in the metal. By permission of Richardson I examined the opening, and took such samples for assa were thought proper. The shaft, to the depth of fifteen feet, with a tr verse measure of about seven feet, had been sunk the whole way on slope of the strata, which were of the same character as those already cribed. The chloritic and epidotic gneiss appeared to be much intermin with calcspar and bitter-spar, which ran in short lenticular interlock patches, each an inch or so thick, in a total width of about eighteen inc at right angles to the stratification, and in place of them there were oc sionally small openings partially filled with the ferruginous earth, in sev of which gold was detected. The opening at the bottom, which was a nearly circular shape on the plane of the bed, and about eighteen inc across the stratification, appeared to include the whole thickness of band holding the smaller dolomitic patches and cavities above. It was p tially filled with the same brown ferruginous earth as before mention with which black carbonaceous matter was much intermingled. In so parts of the opening this black substance appeared to adhere to chloritic schist, and in others to the dolomite.

From this opening* I extracted about three pints (by measure) of ferruginous carbonaceous earth, and the following were the results of so very rude experiments tried on the spot. Taking a pint of the earth, j as it came from the opening, it was reduced by washing to one-half bulk, and when dry the residue was pulverized. Spreading the lat in a shallow tray the lighter substnces were removed by continu shaking and gentle blowing, and there remained a dark colored gold du in which were a few angular fragments weighing from one to three-and half grains each. The whole of this dust weighed fifteen pennyweigh but there can be little doubt that by the rough method used a considera amount must have been lost. In a second experiment two-and-a-h

* Now known as the Phœnix Mine, 1870.

its gathered by me, yielded, by a rude washing and amalgamation, enty-six pennyweightsof pure gold. Rough as these experiments were, ey afforded sufficient proof of the unusual richness of the deposit. ; this time no trace of the metal was observed in the enclosing rock, t shortly afterwards some very beautiful and rich specimens from the ne opening were shewn me, in which the gold was enclosed in the lomite and calcspar.

Shortly after the examination just alluded to, in consequence of disputes nnected with the mine, the shaft was closed up, and no farther examin. on was permitted. On the arrival, however, of Mr. Michel on behalf of e Geological Survey, some weeks later, he with difficulty obtained a hurd view of the opening, and the results of his observations subsequently peared in a Report addressed to you on the 29th January, 1867.

The seat of the gold in the Richardson Mine does not appear to me to a true vein, but simply a series of crevices or openings in a goldaring bed, formed of chloritic and epidotic gneiss holding patches of dolote and calcspar, the openings being nothing more than such as are so en met with in the dolomites and calc-schists of this region as almost to title them to the appellation of cavernous. Thinking it therefore possible at the gold of the Richardson Mine might be confined to a special horizon, proceeded to trace out the rocks at the junction of which it occurs on e Richardson lot, and it may now be stated that some recent and reliable scoveries made during the season of 1868 seem to make this conjecture obable.

The rocks of the Richardson lot are exactly similar to those which have en described as running though the farms of O'Hara and McKenzie in e fifth range of Madoc, which are, however, on the opposite side of an ticlinal, and the seat of the gold seems to be at the junction of the ca-slates (C 2) and the dolomites (C 1) of the section there desbed. This position would be at no great distance above the ferriouss band, and the course of that band, as already given, may thus become guide not only in the search for iron, but for that of gold also.

In Elzevir, Madoc, Marmora, Lake and Tudor the number of localities which openings have been made in the rock by prospectors in search of ld are too numerous to be mentioned. It would, perhaps, be too much say that every lot had been tried, but it appears to me that the exceptns, particularly in Marmora and Madoc, cannot be very many. Of ese localities I may say that I have visited all in which gold was reported have been found, particularly when it was understood that an excavan of some depth had been made, and the work was still in progress. In me cases admission to the excavation was refused to me, and in others, consequence of disputes in regard to ownership, excavations have been

Trials for gold.

filled up to prevent access by the public. A large number of specim however, have been brought to the Survey office for analysis, but all t localities in which, up to the present time, the occurrence of gold has l verified, appear to have the same relation to the ferriferous belt, and be geologically above it, but never at a great distance.

Localities of gold.

The localities on which I would rely as supporting this view are inclu in the following list, in all of which the occurrence of gold, in greater or quantity, has been verified :

Marmora,	range	IX	lot	6	Gold in quartz holding iron pyrites and mispickel, interstratified in a silicious dolomite, sometime association also with chlorite-schist.
"	"	"	"	7 & 8	" " " " "
"	"	VIII	"	6	" " " "
"	"	VIII	"	8	" " " "
"	"	VIII	"	9	" " " " "
					The gold in these four lots stands in the same str graphical place in relation to the Marsh iron ore b which is on the fifth lot of the ninth range of Marm and thence strikes northward parallel with gold-bearing rock.
"	"	X	"	15	Gold in quartz and sulphurets scattered through a s cious dolomite, and sometimes in connection w an interstratified chloritic schist.
"	"	X	"	16	" " " " "
"	"	XI	"	15	" " " " "
"	"	XI	"	16	" " " " "
					On this lot is situated the Feigel mine, and the g in it and the preceding lots is in the same stra graphical place as before.
Madoc	"	IV	"	18	Gold in cavities with ferruginous earth and carbonace matter resulting from the decomposition of sm interposed layers or irregular veins of bitter-sp etc., between layers of chloritic and epidotic gnei and also of dolomite, in which latter rock al gold is sometimes seen.
"	"	V	"	18	Gold in the same conditions as before. This is t Richardson mine, and in this and the previo locality the stratigraphical place of the gold is the same relation to the iron ore of the seventeen lot of the fifth range of Madoc as it was to the Mar iron ore in the previous instances.
"	"	VI	"	1	Gold in antimonial gray copper ore forming small vei with calcspar, bitter-spar and quartz in a brow weathering dolomite belonging to the same band a before, and associated with chloritic and epidot gneiss. This is the Empire mine, occurring in th village of Madoc.

gerford, range XIV lot 9 Gold in traces in antimonial gray copper ore occurring in nests with quartz, in white and pinkish crystalline limestone, which is associated with dolomites supposed to be on the same horizon as the dolomite above the ferriferous band.*

These various localities seem to have a pretty uniform relation to the ·iferous belt, and the existence of gold is reported in many other loca- ·s on the same geological horizon. I have little doubt that it occurs in ıy of them, but have not yet been able to verify its presence in them my own observation. I must refrain, therefore, from doing more than ·r to the general course of the iron-bearing band, which has already n indicated, a close proximity to the summit of which will, in my ıion, afford the most probable positions for the discovery of gold.

A number of specimens from openings reputed to yield gold were col- ·ed for assay in various parts of the county of Hastings, and I give, in clusion, the results of their assay by Dr. Hunt, the method employed ıg the same as that described by him in his Report for 1866, p. 80, and amount of ore treated in each case 100 grammes (1543 grains).†

In addition to the localities cited above, gold is mentioned by Mr. Michel as occur- on the second lot of the fifteenth range of Elzevir, and I have myself, since the date ıis Report, found small quantities of gold by assay in specimens brought by me from second and third lots of the fourth range of the same township. The rock in ·r locality is a mixture of quartz and carbonate of lime, holding bunches of the · and pyritous sulphurets of copper, and it appears to be an interstratified bed, · similar to that above mentioned in Hungerford.

The following assays were made by Prof. Jas. T. Bell, of Albert College, Belleville, are given as confirming of the great richness of the ore from the Empire mine :—

adoc village, range V., lot 2.—Shaft, Empire mine ; antimonial gray copper ; three assays by five vieided respectively per ton, of gold and silver united, \$483, \$492, \$497.

r. Bell informed me that during the month of May, 1868, he visited this mine and cted samples, of which the following are assays :—

wo pounds were submitted to amalgamation, and free gold was obtained at the rate 1.35 to the ton. The concentrated sulphides (one ounce) were smelted, and one n of silver and 0·034 grains of gold were obtained, being equal to

66 oz. 13 dwt. 8 gr. of silver per ton.
2 " 5 " 8 " gold "

ı addition to the lists of localities in which the presence of gold has been verified by personal examination, and by assay of specimens in the laboratory of the Geological vey, I now give, in addition, several other localities, in which the existence of the cious metal has been observed by persons worthy of confidence, more particularly by Michel and Prof. Jas. T. Bell :—

Madoc,	Range	IV., Lot 15.	10.	Madoc,	Range	VI., Lot 29.	18.	Elzevir,	Range	II., Lot 15.
"	"	V., " 9.	11.	"	"	VI., " 30.	19.	"	"	III., " 9.
"	"	V., " 24.	12.	"	"	VII., " 18.	20.	Hungerf'd,	"	X., " 19.
"	"	V.. " 27.	13.	Marmora,	"	VIII., " I0	21.	"	"	X., " 20.
"	"	V., " 28.	14.	"	"	IX., " 9.	22.	"	"	XI., " 19.
"	"	V., " 59.	15.	"	"	X., " 8.	23.	"	"	XII., " 23.
"	"	V., " 30.	16.	Elzevir, E.	"	I., " 10.	24.	"	"	XII., " 24.
"	"	VI., " 16.	17.	"	"	II., " 5.	25.	"	"	XIV., " 3.
"	"	VI., " 17.								

Dr. Hunt's assays.

1. Madoc, range V. lot 2.—Dolomite adjoining the veins at the Empire m as free as possible from sulphurets. Trace of g not more than 1 dwt. per ton.

2. " " V., " 2.—The ore from the Empire Mine was an antimor gray copper (fahlerz), associated with some cr tals of mispickel, iron pyrites, and a little gale The washed and dressed ore gave to analy besides copper, antimony and sulphur, sm amounts of arsenic, iron, zinc, lead and sil with a portion of gold. 53 ounces from vein, gave by crushing and washing 6¾ oun equal to 13 per cent. of ore, still containing ab one-fourth its weight of sparry matter. The ass yielded a button of silver rich in gold, amounti for the ton of 2,000 pounds of dressed ore, to—

9·72 ounces of gold......	$206.50
120·74 " " silver.....	155.70
	$362.20

Making allowance for the proportion of gang equal to one-fourth, still remaining in the dress ore, we have for the pure ore a value of $482.9 A trial of selected fragments from the same mi in which the amount of sparry matter was n determined, gave as follows for 2,000 pounds:—

4⅗ ounces of gold........	$ 96.46
57 1-6 " " silver.......	73.74
	$170.20

3. " " V., " 17.—Sparling's mine, Eldorado, dolomite; said to ha yielded $53 gold per ton. No trace of gold.

4. " " V., " 18.—Richardson mine, from shaft. No trace of gold.

5. " " V., " 18.—Richardson mine, gray silicious dolomite, with som disseminated pyrites. A trace of gold.

6. " " V., " 18.—Richardson mine, ferruginous earth from cavities i the rock, yielded by amalgamation, from a trac of gold, up to $380 per ton. (See page 166.)

7. " " VII., " 17.—Madoc Mining Co., a fine-grained, bluish dolomit said to have yielded 13 oz. 10 dwt. of gold pe ton. It gave, on assay, only a trace of gold.

8. " " XI., " 16.—Shaft; quartz from a vein, with iron ochre. Trac of gold.

9. " " XI., " 16.—Same shaft; quartz, with ochre. No trace of gol

10. Marmora, " I., " 30.—Shaft; quartz, with black tourmaline. No trace o gold.

11. " " III., " 15.—Shaft; micaceous dolomite with thin quartz seam Trace of gold.

12. " " V., " 17.—Shaft; John's mine; vitreous quartz, with som pyrites and native copper. No trace of gold.

13. " " VI., " 18.—Shaft; quartz with bluish tourmaline, calcite, and some ochreous matter, in greenstone. No trace o gold.

Marmora,	range IX.,	lot 7.	—Shaft at Berry's mill, sixty feet deep, on a vein four feet wide; gangue, quartz with mispickel, pyrites and free gold. Yielded me, by fire assay, 4 dwt. 3 gr. per ton. A specimen, in which gold was visible, yielded as high as 9 dwt. to the 2,000 lbs.
Belmont,	" II.,	" 18.	—Specimen from shore of Belmont Lake; a reddish-weathering mica slate, with ferruginous quartz seams. No trace of gold.
Lake,	" III.,	" 12.	—Shaft; vein of quartz. A trace of gold.
"	" III.,	" 12.	—East vein; concentrated sulphurets, roasted, yielded a little over $7 per ton.
"	" III.,	" 13.	—Dolomite, and Deer River. A tracé of gold.
Elzevir,	" IV.,	lots 2, 3.	—Antimonial gray copper ore, in a calcareous gangue. A trace of gold.

In the assays 16, 18, 19, the amount of gold in no case exceeded one t. to the ton.

Bismuth.

Bismuth.—The occurrence of carbonate of bismuth in the township of dor has been alluded to by Dr. Hunt in his Report on the gold region Hastings, in 1867, (page 6). It was found on lot thirty-four of the rd range of Tudor, in a vein cutting the hornblendic rocks of division B, d an overlying magnesian limestone, the dip of which was about forty-e degrees to the north of west. The vein, which is very irregular in e, sometimes attains a breadth of two feet or more, and runs north-west, pping at a high angle to the south-westward. The veinstone was chiefly reous quartz, carrying near the surface small masses of carbonate of muth, which, lower down, were replaced by the sulphuret, with traces metallic bismuth. Fine crystalline specimens of the sulphuret of muth, several ounces in weight, were sometimes met with; but this luable ore was sparsely and irregularly disseminated in the quartzose ngue, which also enclosed irregular layers of impure graphite, and sses of radiated black tourmaline, which were sometimes found to pene-te the bismuth ore. In sinking, the quartz veinstone was in parts placed by an aggregate of pink crystalline calcspar enclosing small ystals of yellow mica, which were also met with in the adjacent quartz. on pyrites in imperfect crystals and small masses was also observed in calcareous portion of the vein. Dr. Hunt, to whom I am indebted for ese notices of the minerals of this curious vein, assayed the bismuth ore gold and silver, but found neither. After considerable working this in was abandoned in 1868.

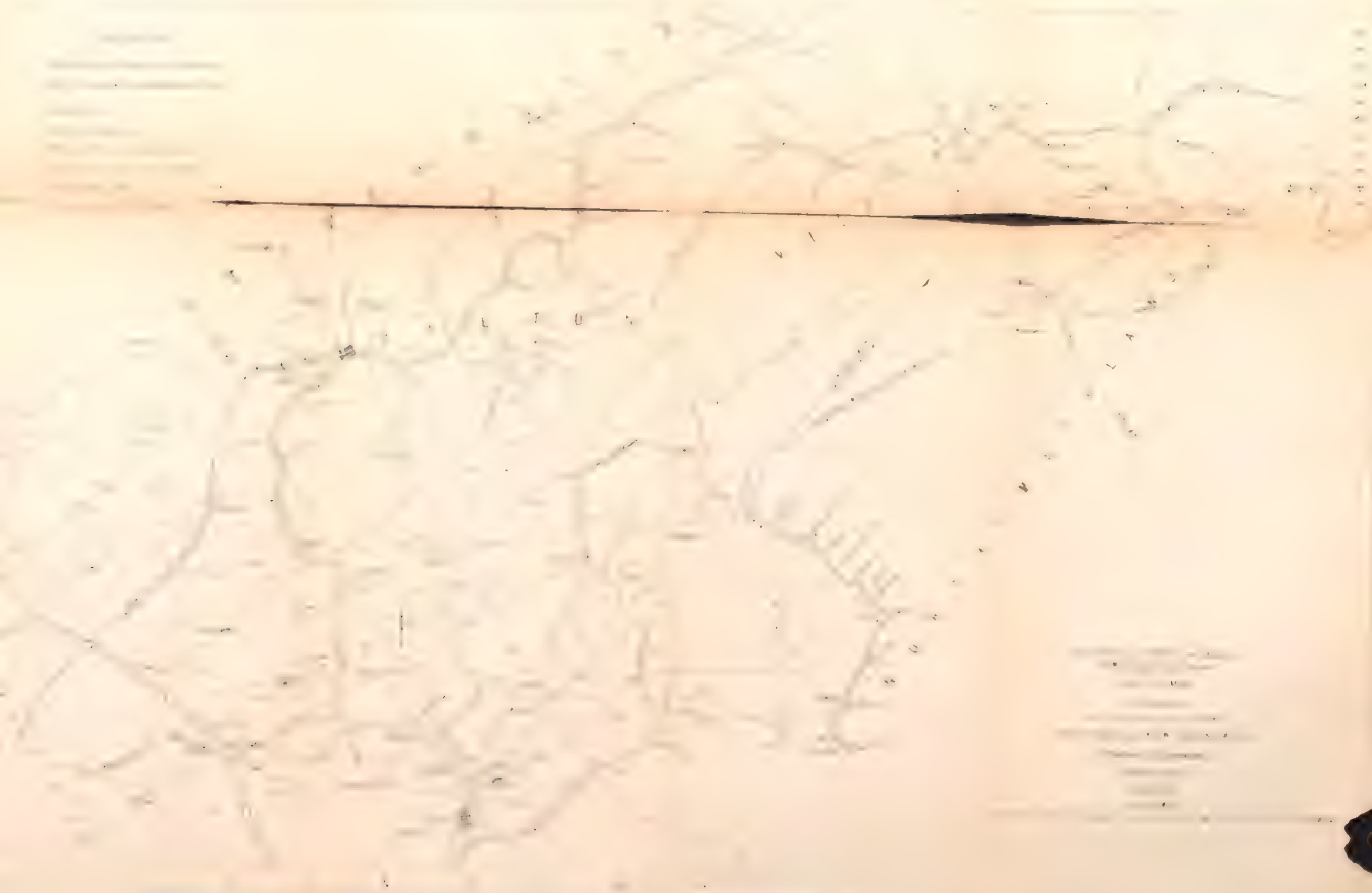
I have the honor to be,

Sir,

Your obedient servant,

HENRY G. VENNOR.

St. John.



REPORT

OF

MR. CHARLES ROBB,

ADDRESSED TO

SIR WILLIAM E. LOGAN, F.R.S., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY.

MONTREAL, 22nd April, 1869.

SIR,—Having, in the month of May last, been honoured with your ıstructions to visit and make a geological examination of certain parts of ıe Province of New Brunswick, I immediately proceeded thither, and ave devoted to that object the remainder of the season suitable for field ork.

The region indicated by you as that to which you deemed it desirable bestow attention in the first instance, is that lying towards the northern ase of the great coal area of the Province, comprising, in addition to the arboniferous rocks themselves, an extensive belt of metamorphic and ranitic rocks, the age and conditions of which had not been previously scertained. I also understood it to be your desire that I should invesgate incidentally, in the course of the season, the facts relating to the iscovery or probable occurrence of economic minerals in the region eferred to.

Of that part of the Province above indicated by far the greater proortion is still in the state of an unbroken wilderness, the settlements being onfined for the most part to the banks and immediate vicinity of the ver St. John and its principal tributaries. In order, therefore, to obtain, River St. John.
ı the readiest manner, a key to the geological structure, I deemed it dvisable to commence with the examination of the banks of the St. John iver itself, which affords a transverse section of the formations ; and of the ıore accessible districts on either side. Accordingly, my explorations of st summer and autumn have extended over the greater part of the counes of York and Carleton, and the south-eastern part of Victoria, in which

discoveries of gold had been reported, and lands leased for gold-mi
purposes. The area over which my observations have extended ma
estimated at 5,000 square miles; but for various reasons, which I
state, the work must be regarded rather as a preliminary reconnaiss
than a complete and detailed survey.

Geological map.

In the accompanying map, which I have compiled from the most aut
tic available sources on a scale of two miles to an inch, and on the apper
sections, I have recorded many of the details of my observations; an
the smaller map, reduced from the former to a scale of eight miles t
inch, I have indicated, by appropriate colouring, the general results.*
procuring the materials for the compilation of the maps, I have grate
to acknowledge the courtesy and kindness of the gentlemen conne
with the Crown Lands Department at Fredericton.

At an early stage in the course of this investigation it became evi
that, in so far at least as regards the great area underlaid by the m
morphic and granitic rocks, the attempt to conduct a systematic
minutely detailed geological survey without a previous general recon
sance, would, for various reasons, be beset with difficulties and atten
with disappointment and loss of time.

1. Owing to the altered and contorted condition of these rocks
obscurity and difficulty incident to the investigation of all such region
experienced here in full force. The lines of original stratification
either obliterated or so complicated with the superinduced planes of cl
age, foliation and jointing as, in the absence or very rare occurrenc
fossils, to render the stratigraphical relations of their component p
extremely embarrassing and difficult to trace. The remarkable uniform
in mineral character and conditions, as shown in the river sections, is
extremely perplexing when it is attempted to determine the order of s
cession or thickness of the various members of the formation. This difficu
is further complicated, where differences in this respect do occur, by
gradual manner in which the rocks appear to blend with each other,
by the absence of well-defined and characteristic bands capable of be
traced for great distances on the strike.

2. Although the transverse sections afforded by the St. John
Southwest Miramichi Rivers (which run approximately parallel to each ot
at the distance of about forty miles apart) are good and easily accessi
they are too far apart to be co-ordinated for the purpose in view, and
the intervening region, which is still for the most part a trackless wildern
the rock exposures are few and their position uncertain and difficult to fi

3. In the absence of reliable topographical maps, and of landmarks
any kind in the interior of the country, the difficulty of bringing into p

* The smaller map is the one published with this Report.

n any geological observations would be extreme. I am aware that in the ogress of your surveys in Canada, you have encountered and overcome nilar difficulties, on a large scale; but it appeared to me a matter for con- eration how far, at the outset, I should be justified, under all the circum- nces, in incurring the delay and expense of investigating minute local tails, the connection of which would necessarily be so vague and scure.

In consideration of all these circumstances, it has appeared to me that a nprehensive general view of the whole conditions of the case would be a cessary preliminary even to the institution of an intelligent and economi- method of subsequent procedure, and would afford at the same time an portunity of making special examinations of those localities, sometimes great distances apart, where valuable minerals were reported to have en discovered.

Accordingly, my observations will be found, on the whole, to be more sultory and indefinite, as materials for a systematic survey, than they uld otherwise have been, or than I could wish. I have, however, on occasions striven to make them as accurate as possible in regard to ition, by reference to the Crown Lands Surveys, and to all available dmarks, natural or artificial, such as prominent bends of rivers and eams, occurrence of islands, junctions of tributaries, mile-trees, roads, ., and by bearings to all conspicuous elevations. In determining the of junction of the Carboniferous and metamorphic rocks, I have follow for the most part, the usual method of pacing, where points occur in the nity whose position is known with any degree of accuracy. In illus- ion of the mineral character of the various districts, I have collected a of rock specimens and fossils, which are also herewith submitted.

The geological features of the region in question have been investigated ome extent and described in general terms by the late Drs. Gesner and ob, and also by Dr. Dawson, Professor Bailey and Professor Hind, to ose labours I am indebted for much valuable assistance in the prosecu- of my own.

General divisions.

For the convenience of classification I shall, in anticipation of the results e hereafter detailed, divide the record of my observations into six dis- t sections, corresponding with the geographical and geological lines upon small map.

. The section of country lying towards the south-east part of the county York, and overlaid by the nearly horizontal unaltered rocks of the Car- iferous series.

I. The belt or band of metamorphic rocks immediately underlying the ner, up to the south-eastern boundary of the great granitic area.

II. The so-called central granitic area.

IV. The band of non-calcareous metamorphic slate and quartzite l immediately to the north-west of the granitic area.

V. The north-western part of the county of Carleton, occupied for most part by altered calcareous clay slate; and

VI. The Tobique valley and its tributaries, in the counties of Vict and Northumberland.

N. B.—Throughout this Report the bearings are stated with refere to the astronomical meridian; the variation of the compass at the tim my visit was 19° 20′ W.

I. THE CARBONIFEROUS AREA.

Lower Carboniferous.

This formation, (in which for the present I include the lower red sa stones and conglomerates usually regarded as Lower Carboniferous), in far as hitherto examined by me, is comprised between the southern bo dary of the county of York and the unconformable altered slates to north-west. This, however, constitutes only a portion of the northern of the great Carboniferous area. The line of out-crop, or junction of the distinct series of rocks, which is rudely parallel to the strike or gene direction of the older rocks, is delineated upon the map from my o observations and measurements at a great many points.

The Carboniferous (or more properly, perhaps, Lower Carbonifero rocks, in the northern part of New Brunswick, consist of a series of se mentary deposits, evidently composed of the debris of the more ancie metamorphic rocks; and rest unconformably and almost horizontally up the upturned edges of the latter, filling up pre-existing hollows and ba and but slightly altered in mineral composition, except where invaded, intervals towards the base, by rocks of igneous origin. Owing apparen to these irregularities in the surface of deposition, and to the prevalence other disturbing influences, it is difficult to give any exact definition the component parts of this Lower Carboniferous series, their respecti volumes, or even of the order of their succession.

Lower conglomerate.

The lowest member, resting immediately upon the metamorphic slat and apparently dipping, at and near the line of contact, in conformity wi their previously denuded surface, is a coarse dark red conglomerate, co posed of rounded and flat pebbles, generally, though not always, water-wo and consisting of slate, quartz, trappean, and older conglomerate rocks all sizes up to eight inches diameter. Such of the pebbles as are of a soft or more permeable nature are stained red and sometimes green, doubtle from the penetration of ferruginous matter. The whole mass is cement by a calcareous and arenaceous paste, sometimes, especially towards t base, with crystalline calcite. Wherever this red calcareous conglomera

sts immediately on the metamorphic slates, the latter seem to partake the same characteristics, becoming more or less tinged with red and een colours, and impregnated with calcareous matter, which appears th throughout the substance of the slates, and in veins and strings of calca-ous spar, frequently associated with quartz, intersecting them. The lcareous impregnation diminishes in intensity as we recede vertically or rizontally, as the case may be, from the junction of the two formations.

Succeeding the red conglomerate, which generally becomes finer towards e summit, are red sandstones, also calcareous, but more sparingly so, th occasionally interposed thin and irregular layers of red shale, some-nes so free from grit as to make a good pigment. Both sandstones d shales are sometimes highly micaceous, and the calcareous matter ems gradually to diminish in quantity from the base upwards. No fos-s have been observed in these red conglomerates, sandstones and shales, e aggregate thickness of which, from observations made at several ints, I have reason to believe to be about 1000 feet. Sandstones and shales,

Then follows, but only at irregular intervals, a coarse, silicious conglom-ate, composed entirely of rounded white quartz pebbles with a cement nsisting of fine grains of sand and feldspar, and totally devoid of lime ; ove which, in very considerable volume, repose coarse grey grits or ndstones and conglomerates, also devoid of lime, abounding with carbon-d casts of calamites, cordaites and other obscure vegetable remains, and lding occasional thin seams of coal. These last mentioned rocks consti-e, in that part of the region examined, the most prominent feature in e main Carboniferous area. Occasionally they are fine grained, and fit grindstones ; sometimes flaggy, in tolerably regular and thin layers, t generally very coarse grained and massive, extremely irregular in the e of the component particles, and partaking, even in the same beds, of the xed character of sandstones and conglomerates. The paste is felds-thic, and sometimes shows the result of decomposition in the presence of all portions of kaolin among the particles. Upper conglomerate.

Although the general colour of these rocks is grey, they are occasionally ldish, purple and yellow, and more rarely of a greenish hue, and some-nes stained black with oxide of manganese ; these differences being parently quite capricious in their modes of occurrence, depending rather on local circumstances than upon the stratigraphical position of the beds hibiting them. At the few spots where thin seams of coal have been dis-vered, they are overlaid by a correspondingly thin band of drab coloured enaceous and micaceous shale, showing scanty and imperfect impres-ns of ferns and other coal plants, and rest upon a similar stratum, ounding in nodules of iron pyrites, but destitute of organic remains, so far I could discover. I am not aware of any true stigmaria underclays or Coal seams.

other indications of productive and workable coal seams having been fo in the region under notice. Near Thompson's Mills, at the mouth of Nashwasis, about three miles north of Fredericton, two large prost trees have been found imbedded in the solid sandstone, one measuring feet long and two feet diameter at the base ; of these I have obta fragments, but the species has not yet been identified.

General dip.

The attitude of the various strata above enumerated, which appear the whole to be conformable, is nearly horizontal. From local irregularit however, in the apparent surfaces of bedding, it is exceedingly rare obtain an unequivocal observation of strike or dip by direct measurem and from the want of continuity of the beds their precise attitude car be deduced from bearings and levels taken at moderately distant poi From a somewhat comprehensive series of observations, I believe I justified in setting down the average dip, throughout the region explo by me, as E. 6°—10° S. at an angle of 5°. This is at and near the of the area; as we proceed towards the centre the strata become more a more nearly horizontal.

Soils.

The grey grits and conglomerates being composed of materials li liable to disintegrate by the influences of the weather, especially towa the outer rim, have resisted denudation, and are generally found standi out in bold bluffs or more shelving ridges of various elevations up to 9 feet above tide level ; while the softer and more readily decomposed r and calcareous rocks at their base occupy lower ground, and partia influence the course of some of the rivers; their ruins producing, as mig be expected, good arable land. The grey sandstones, on the other han produce by their disintegration rather poor and meagre soils ; and t uplands overlying these rocks being either for the most part encumber with loose blocks, or swampy from want of natural drainage, the progre of agriculture in such circumstances is necessarily slow.

The trappean rocks to which I have referred as associated with th group, occur only in connection with its lower members. The areas these eruptive rocks, of which I have noted seven distinct localities in th region explored by me, are generally of very limited extent, but local they appear to have exercised a considerable influence upon the characte and distribution of the rocks penetrated and overlaid by them.

Carboniferous area.

Having thus indicated the general features and conditions of the Carbon ferous rocks in this region, I shall proceed to give a few details of the mor notable localities in which they were observed. It has been long know that the great Carboniferous area of New Brunswick has a triangular form the base resting on the Gulf of St.Lawrence, and the apex situated a littl

the west of Oromocto Lake, near the boundary line between the counties 'York and Charlotte. It is at this latter point that my observations mmence, extending thence in a north-easterly direction to the county of orthumberland, at Boiestown on the Southwest Miramichi River. The ver Magaguadavic skirts this line transversely just at the apex of the rboniferous triangle, and seems to have excavated its channel in the ft calcareous and marly rocks at the base of the formation ; the country yond, to the west and north, forming a very extensive elevated plain, derlaid by the metamorphic rocks. The succeeding members crop out bold bluffs, nearly 250 feet above and two-thirds of a mile from the er; the apparent dip being N. 70° E. $<15°$. The section may be bulated thus, in ascending order :—

	Feet.
1. Red conglomerate and marl with impure hematite, to base of cliffs.......	60
2. Red calcareous sandstone moderately fine-grained......................	45
3. Purple sandstone, cut vertically and transversely in one place by a two-feet dyke of trap running east and west, which has to a small extent hardened and altered the rock in its immediate vicinity..................	30
4. Reddish-grey coarse sandstone becoming conglomerate in irregular patches in the beds. The pebbles are of all sizes up to two inches diameter, chiefly of quartz and quartzite...................................	30
5. Yellowish coarse-grained sandstone with large quartz pebbles and obscure vegetable impressions...	50
6. Grey and purple coarse sandstone, occasionally stained black with oxide of manganese, to top of cliff..........	35
Total............	250

Magaguadavic section.

Oromocto Lake, which is situated two miles eastward from the brow of e cliff, and is about sixteen square miles in superficial extent, is from 80 100 feet below the level of the escarpment referred to, and 370 feet ove the level of tide water, while the general level of the great plain to e west is 250 feet ; thus presenting the extraordinary phenomenon of a y considerable body of water supported at a height of 120 feet above e plain in the immediate vicinity, and yet draining through a very great ea in the opposite direction. At Lister's Mills, ten miles north from the arpment, and on the north-east branch of the Magaguadavic, the rocks the base of the Carboniferous series present an interesting development their peculiar characters where affected by trappean intrusions. Mottled l and green highly calcareous shales and conglomerates, some of the ers holding nodules of pure calcspar, layers of chert and strings of fluorr, occur mixed with rocks apparently of eruptive origin, and with others ring much resemblance to the older metamorphic rocks. Oromocto Lake.

The eruptive rocks which, to a limited extent, appear here, are situated the south-western extremity of a lenticular shaped area about nine miles Eruptive rocks.

in length by a little over one mile broad in the middle, occupied by rc of a similar nature, attaining their greatest development at Bald Moun and other bold bluffs at and near the foot of Cranberry (or Bear) La This mass is flanked to the south by a considerable breadth of the red careous conglomerate and marl formerly described, forming the fe tract of Harvey Settlement; and on the north by an extensive flat elevated table-land, underlaid by the metamorphic slates; the water-s between the streams flowing into the St. John River and Passamaquo Bay respectively. The eruptive mass appears to consist of a central underlying part or nucleus of very hard and heavy dark red or pu compact quartziferous porphyry, holding a little calcareous spar, fluor-s and traces of copper ore in cracks and crevices, overlaid and envelo first by hard close-grained and homogenous yellowish-brown claysto resembling overburnt pottery-ware, and then by a rock apparently ide cal in composition and equally close-grained, but finely laminated in pu and pink streaks, as if deposited from solution in water; the former be the more quartsoze, and the latter the more feldspathic portion. T laminæ run in the general direction of the length of the mass, and di opposite directions on either side of it, generally at an angle of 45°, with many and violent contortions.* The conglomerate and marl of lower member of the Carboniferous series appear to a very limited ext to the north of these rocks, but are chiefly developed in the opposite di tion.

A good section of all these rocks is afforded by the railway cutting the foot of Cranberry Lake; but as it intersects them longitudinally, or a very oblique angle, it does not throw much light upon the structure, in far as measurement is concerned. The following may be taken as

Thickness.

approximate estimate of the thickness of the various members of what a considered as belonging to the trappean mass, that of the sedimenta strata being here obscure;—

		Feet.
1.	Central mass of quartzose porphyry, (breadth)	1800
2.	Claystone, compact and close-grained, (thickness)	1250
3.	Laminated and contorted quartzose and feldspathic rock, (thickness).	600

Within the limits of the trappean area described are four hills compos of these rocks; the highest of these, called Bald Mountain, is about 380 fe above the plain, with a steep mural face to the west, near the base of whi at one point I observed the claystone trap overlying a coarse conglomera either of an eruptive or highly altered character. The other elevations a

* The central rock appears to bear a strong resemblance to an eruptive rock de cribed and analyzed by Dr. Hunt under the name of *orthophyre* as occurring in t township of Grenville, Quebec. (See *Geology of Canada*, page 654).

out 220 feet in height, all very near each other, clustered around the t of Cranberry Lake, and about the centre of the eruptive area.

A little coal is reported to have been found in the grey sandstone overng the red conglomerate in Harvey Settlement, and hopes have been tertained in the locality that this might lead to workable deposits ; but so far as regards the character and condition of the rocks here, there is le to justify such an expectation, since they are situated quite near to e base of the Lower Carboniferous, and appear to be devoid of the charteristic underclays which accompany workable coal seams.

About half-way between the St. Andrew's and Fredericton road, and e sharp bend of the St. John River at the mouth of Long's Creek, the nction of the metamorphic and Carboniferous rocks is well exposed near e house of Nicholas Barker ; where the former are seen dipping N. W. 80°, and the latter, now free from the influence of intrusive rocks, out S. E. $< 20°$, both being highly calcareous towards the junction. The bbles of the red conglomerate here, especially towards the base, are for e most part angular, composed of slaty and trappean rocks, and of all sizes to six inches. The breadth of the conglomerate band and its associated d rocks is here over half a mile, and the thickness, assuming the dip to uniform, about 1000 feet. Coal.

About five miles to the eastward of this point, where a section of the cks is afforded at Kelley's Creek, the red rocks do not exceed one ndred paces in breadth ; beyond which they no longer appear to come the surface, nor have they been observed by me in the whole distance ence to the main river, upwards of nine miles. The silicious conglomere and coarse grey sandstone are observed in this interval in immediate ntact, dipping in opposite directions at high angles, and both devoid of lcareous matter. The Fredericton and St. Andrew's road runs for this tire distance parallel to and a little south-east from the line of junction these formations, occupying an elevated though irregular ridge of the ey grits, at an average height of 400 feet above the main river, the tritary streams running in opposite directions on either side of this ridge. n approaching the River St. John the country underlaid by the metaorphic rocks becomes more rugged and mountainous ; and at and near pringhill, five miles from Fredericton on the Woodstock road, cliffs of these cks rise to the height of from 300 to 500 feet, generally with steep mural ces to the north and east. The junction of the metamorphic and Carbonirous rocks on the right bank of the river, although concealed by the iperficial deposits, I have good reason to believe to be about four and a lf miles above Fredericton, near to which point the attitude of the Carniferous rocks, where exposed, is ambiguous and perplexing ; in one stance I observed the grey grits dipping apparently at an angle of 65° the S.E. Springhill.

In tracing the line of junction to the north-east we find evidence on reaching the main river it coincides with its course, and runs unde bed for a distance of four and a-half miles; that is, from the point al noted, to a little below the ferry at King's Clear, where it again co out on the right bank; and enclosing a circular area of about two and a- square miles, crosses the river at Indian village to Keswick Bluffs, thence skirts the right bank of the Keswick River for about five miles f its mouth. The line I have described forms, as will be seen by the ma deep sinus or bay in the older rocks, which is occupied by elevated ridge highly contorted and altered slate and quartzite. Near Springhill, at mouth of Sutherland's Creek, and at a few other points along this l where exposures occur, these rocks are observed to become red and careous, probably from proximity to the red conglomerate and marl, whi however, do not actually appear in place on this side of the river u

King's Clear.

reaching the area at King's Clear, formerly regarded as an outlier of formation. Here the strata lying at the extreme base of the Carbonif ous series, are well exposed; consisting chiefly of alternating thin beds red conglomerate and marl, the latter occasionally holding nodules of lin stone; and the conglomerate, when in contact with the slate, being compos chiefly of angular fragments of that rock, which, in ascending, are gradual replaced by rounded and transported pebbles.

On the opposite side of the river, which is here expanded to an avera breadth of about one and a-half miles, and studded with large alluv islands, the red conglomerates and sandstones are displayed in conside

Clarke's Mountain.

able force from Clarke's Mountain, opposite Springhill, to Keswick Ridge the right side of the river of that name. Clarke's Mountain is a dom shaped trappean mass or knob rising in a bold and picturesque manner fro the brink of the river to the height of 280 feet. The rock is a mass very hard and heavy close-grained blackish-green basalt or dolerite, wit perpendicular joints running east and west, about eighteen inches apar and another set dipping S. E. $<25°$. At the river-bank it is seen reposin on nearly horizontal coarse red sandstone and conglomerate to the heigh of thirty-five or forty feet, and traceable about two miles up the river where it attains a height of 350 feet; giving a total thickness of abou 1000 feet to the red rocks at this point, where the eruptive rock whicl caps them, with a steep face to the river for the whole distance fron Clarke's Mountain, appears to terminate in a wedge-shaped point, giving place to the grey sandstone and conglomerate.

The mineral character of the eruptive rock, in its continuation westward from Clarke's Mountain, is somewhat different from that found at the latter place, as above described, being of a lighter colour and inferior density, with less regularity in the arrangement of joints; vesicular and amygda-

lal, the amygdules being composed of calcspar, green earth, and occa-ıal zeolitic minerals. From the termination of the wedge-shaped erup-mass northward, the grey grits and conglomerates form the continua-. of these high lands; rising to an elevation of from 400 to 500 feet, and ting the left side of the valley of the Keswick in an amphitheatre of l bluffs, for several miles upwards from the main river.

Three miles due east from this intrusive mass another of similar dimen-s and mineral character occurs. This eminence, which flanks the al Road, on the south side of Nashwasis valley, and is called McLeod's ntain, attains a height of 540 feet, and is capped by the eruptive rock thickness, at the only point where I could obtain an observation, of feet, with a perpendicular face to the west. The rock is vesicular uncrystalline, resembling not so much the basalt of Clarke's Mountain ts supposed continuation to the north-west. Here, too, as at the latter lity, it rests immediately upon soft red and green bedded marls with a to the S. E. < 7°, overlying red conglomerate and shaly sandstone, and uding angular fragments of the latter. Near Easty's Bridge, where Royal Road crosses the Nashwasis, the eruptive mass seems to ter-ate in a very narrow band, at the river, where it is at least 300 feet w its lower surface in the mountain itself. McLeod's Mountain.

From the escarpment of the mountain the ground slopes to the south-east low angle, probably in conformity with the dip of the underlying grey s, which flank the narrow coping of trap. Near the bridge the river des into three branches, and on the north-east branch, about one and arter miles from the Forks, occur the Falls of Nashwasis. Here the k, running in a picturesque gorge formed of nearly perpendicular of yellowish-grey sandstone, 100 feet apart, and about the same height, over coarse silicious conglomerate rocks, forming a cascade of forty high and fifty feet in width. Both the cliffs above, and the conglom-e forming the bed of the stream at the fall are copiously charged carbonized impressions of obscure vegetable fossils, such as leaves and ns, the latter sometimes of considerable thickness, the bark being verted into coal, and the core replaced by sandstone; nodules of iron tes are also very abundant. Although such traces of carbonaceous ter abound, there seems to be nothing to justify the expectation, which been entertained by some of the neighboring residents, that a workable n of coal may be found here. Rumours were current also, when I ed the locality, of veins of manganese and even of more valuable ores ng been found on McLeod's Mountain, together with great deposits of red ochre in the vicinity, but as they were not met with by me, I am ble to give any details. Just below the fall there is a considerable elopment of a pure white silicious conglomerate, composed entirely rge quartz pebbles, and without a trace of organic remains. Falls of the Nashwasis. Fossil plants.

From the mouth of the Keswick, north-eastward as far as Tay s ment, a distance of fifteen miles, the hardness of the out-cropping e of the grey grits and conglomerates, combined with the unequal effec superficial denudations, produces a very marked topographical feature, ing a succession of nearly parallel ridges running north-east and south- as far as the valley of the Nashwauk, and all of very considerable e tion up to 900 feet above tide-water. Most of the rock exposures obse by me in this district have been recorded on the large map, and need be here repeated. In this interval the red rocks are nowhere consp ously displayed, owing to the relief of the surface, the nearly horiz attitude of the strata, and the soft nature of these rocks themselves.

River Tay.

the valley of the River Tay, however, they re-appear in consider breadth, as might be expected from the fact of its cutting the forma transversely. At Boone's Mills, about eighteen miles from Fred ton, on the north branch of the Tay, and near the road between digan and Tay settlements, fossiliferous and highly ferruginous g grits occur in alternating massive and shaly beds, dipping S. E. $<7°$, specular iron and impressions of large and small obscure fossil veget remains. A little farther north, at the bridge over the south branch, bedded micaceous red sandstones appear, dipping S.E. apparently <1 this is at the junction of the red and grey rocks. Proceeding one a-half miles northward on the road, we find at the bridge over the N Tay, the contorted and nearly perpendicular slate and quartzite of unconformable metamorphic rocks, seamed with quartz veins, and sligh calcareous, but only so in streaks and blotches. On descending stream (but ascending in stratigraphical order) the slates become gra ally more calcareous, arenaceous and micaceous, and assume a red colo till at a little over half a mile below the bridge, they are covered by unaltered beds of red marl and conglomerate, dipping S E. $< 7°$.

Tay section.

As the section afforded in the bed and banks of the Tay is tolera complete and distinct, cutting nearly transversely to the direction of Carboniferous rocks, extending for a distance of about ten miles from th base, and including two small seams of coal, I present the following tab lated details of it, in ascending order, commencing at the point indicated the preceding paragraph :—

	F
1. Coarse red calcareous conglomerate and marl........................	1
2. Red and green highly micaceous marl..................................	
3. Calcareous red conglomerate with finer pebbles......................	
4. Red sandstone..	
5. Measures concealed, but probably still underlaid by the red conglomerate marl and sandstone which appear at the commencement of the section	7
6. Highly indurated red sandstone...	

7. Coarse grey grits in a cliff forty feet above river	70	
8. Alternating thin bands of red, grey and greenish sandstone, the grey rock highly micaceous	130	
9. Silicious conglomerate	43	
10. Grey flaggy grits, dipping apparently S.E. at an angle of 30°, but this may be due to false bedding	17	
11. Flaggy grey grits alternating with more massive beds	550	
12. Red and green calcareous crumbly shales	20	
13. Massive grey sandstone	50	
14. Flaggy grey grits overlaid by a coal seam five inches thick, but concealed under the bed of the river	30	Coal seam.
15. Green hard shaly rock containing impressions of calamites and ferns overlying the coal	10	
16. Grey grits thin and thick bedded, irregularly interstratified, and with obscure vegetable fossils	2000	
N.B.—This thickness is given on the presumption that in the four and a half miles intervening between the coal at C. Urquhart's on Tay Creek, and that at Alexander McLean's on the Nashwauk, there is no break, undulation nor change of dip, of the existence of which there is no evidence.		
17. Coal seam of four inches overlaid by green shale, with vegetable impression and grey sandstone to unknown thickness	——	Coal seam.
Total	4005	

At both of the above mentioned localities where coal has been found, the ams themselves are concealed, the former by a considerable depth of ter in the creek, and the latter by a crumbling bank. Thus neither the ality nor conditions of occurrence of these coal seams have been accuely established; but there appears no reason to believe them to be of y economic importance, as no true underclays have been found in this ction of country, and even the continuity of the coal beyond the spots ere it has been found has not been ascertained. The following is a list the plant impressions found by me in the shales forming the roof of the ds; they seemed to be for the most part common to both localities. I indebted to Dr. Dawson, of McGill College, for their identification: Fossil plants.

Calamites cistii, *Neuropteris flexuosa*, *N. Loshii*, *N. tenuifolia*, (or an ied species,) *N. gigantea*, *Pecopteris arborescens*, *Annularia sphenoiylloides*, *Alethopteris grandis*. At a few other localities in the valley the Nashwauk traces of coal have been found, but apparently even less portant than those included in the section.

Between Tay settlement and Stanley, on the Nashwauk, on the land of obert Thorburn, an interesting exposure of the junction of the red calcaous conglomerate and underlying metamorphic slate rock, in vertical secn, is afforded in a small ravine or gorge. The slate rock at and for some stance below the plane of contact is also calcareous, and seamed with rings of quartz and calcspar; in the same neighbourhood this rock was any years ago unsuccessfully burnt in a kiln for lime.

A similar conjunction to the last is well observed, though in horizontal

Nashwauk.

exposures, in descending the River Nashwauk, where, about a mile b Stanley Bridge, the slates, reddened and rendered highly calcar towards the contact, are overlapped by the red conglomerate, sands and marl, which continue uninterruptedly in descending, for a distanc one and three-quarter miles, equivalent to a thickness of about 1000 f and terminate near the mouth of Cross Creek, there giving place to li grey sandstone and conglomerate in massive beds. At Red Rock se ment and also at the month of Cross Creek, eruptive masses of protrude through the red conglomerate near the summit. At Nashw Bridge, on the Miramichi road, thin-bedded flaggy grey grits are seen the bed and bank of the river, dipping S. E. $< 5^{\circ}$; and the same rocks occasionally displayed at intervals along the Portage road to Boiesto About ten miles from Boiestown the road skirts a considerable exten red conglomerate, terminated towards the east by an eruptive mass basalt similar to that at Clarke's Mountain, but more vesicular. It fo the height of land on the Portage, and is about three-quarters of a r wide, terminating at Clear-water Brook, a tributary of the Taxis Riv the other dimensions and precise form of the mass have not been fu ascertained.

South-west Miramichi.

From Boiestown eastward for three or four miles, the right bank of Southwest Miramichi River is flanked by an amphitheatre of the coa grey sandstones rising to the height of 200 feet above the river, and d ping S. E. $<5^{\circ}$; the line of this escarpment is considerably to the south that of the bluffs at Keswick, Cardigan, etc. Near the mouth of the Ta River, which flows into the Miramichi a little above Boiestown, a small sea of coal about three inches in thickness was reported. Four miles up t Miramichi from the mouth of the Taxis, the horizontal grey fossilifero sandstones overlie red conglomerates and marls, dipping $<67^{\circ}$ to the sout east. This high dip, of which some of the beds of the grey grits also see to partake, may be due to a fault; in corroboration of which hypothesis t underlying metamorphic slate is unusually full of veins of quartz and ca spar, as if much fractured; but on the other hand it is to be noted that wi the observed horizontal breadth of the red rocks (400 yards) the thickne would closely approximate to that usually obtained for the red rocks, (10 feet). The grey sandstones near this locality yield very fair thoug rather fine-grained grindstones ; and some of the red marls might be foun suitable for a pigment.

II. SLATE BAND SOUTH OF THE MAIN GRANITIC AREA.

The second district into which, for convenience of description, I hav divided the region explored by me, is that lying between the norther

ndary of the Carboniferous area and the so-called central granitic band; ending in length from Magaguadavic Lake to the Southwest Miramichi, in breadth varying from nine and a-half miles on the St. John River eventeen on the Miramichi; these measurements being taken in straight s at right angles to the strike. The rocks of this district consist of illaceous and micaceous clay slates, with interposed bands of hard fine-ined, crystalline, quartzose, micaceous and feldspathic rocks resembling dstone. These rocks, which doubtless consists of altered sediments, are erally of a light bluish-grey colour, but sometimes greenish and brown n the presence of iron in various states of oxydation. They are fre-ntly traversed by small lenticular veins and strings of quartz, generally rlaminated, but often cutting the rocks in all directions. Occasionally y are more or less calcareous, and chiefly so at and near their junction h the newer rocks.

These schistose and compact rocks, which alternate in irregular bands of ious but generally no great thickness, seem to be only varieties of the e or a similar mineral aggregate, but of different structure. At one it, as I shall presently explain, I have found fossils apparently belong- to these rocks; but, as the stratigraphical relations of these fossils are very obscure, it is extremely difficult to discover the geological age, ginal conditions of stratification, thickness, or the succession of the com-ent parts of the present series. I have observed in the same band of rtzite, (by which, for want of a better name, I shall in the meantime ignate the compact bands) no less than four distinct planes of cleavage, nore strictly cleavage, lamination and jointing, along each of which the k seems almost equally liable to split. Throughout the whole extent of se rocks they exhibit a series of sharp plications and occasional violent tortions, which greatly increase the difficulty of unraveling their struc-e. It is, however, probable that the planes of division between the npact and schistose bands are to be regarded as marking the original s of stratification. From numerous observations, many of which are orded on the larger map, the prevailing dip, when not affected by local tortions, is N. W. $< 60^\circ$–80°; this seems in accordance also with the eral structure of the country viewed comprehensively, and with the ection of the fossiliferous band at the only locality where I have observed Where the plications of the strata are so numerous and so sharp, the so steep and almost uniformly in one direction (indicating overturns) bands of different characters so numerous, so thin, and so much alike, the exposures so few and interrupted, it would be impossible, in the sent state of our knowledge, to construct an accurate section, or to give n an approximate estimate of the thickness of the formation.

Joints and cleavages.

On the right side of the River St. John, the section of the country now

under consideration is for the most part an elevated and uncleared m
flat, with no natural exposures of rock except on the ridge running
the Magaguadavic settlement to the antimony mines, and on the
and in the immediate vicinity of the main river, where numerous
ridges and valleys occur, running in the direction of the strike. Be
what has been already stated in treating of the junction of the Carbo
ous series, and the preceding general remarks upon the metamo
rocks, there is nothing specially worthy of note on this side of the
river, with the exception of the antimony mines in Prince William pa
and the carboniferous outlier in the same parish and in that of Dum
Of the former I propose to give some account under the head of the econ
minerals of this part of the province; and shall only remark here
the rocks of the locality are of the same general character as I
already described, except that they are unusually full of quartz v
some of which contain also calcareous spar, and that they are talcos
their aspect.

Carboniferous outlier.

The outlying patch of supposed Carboniferous rocks, situated a
twenty-four miles from Fredericton, on the river road to Woodstock,
near to the antimony mines, is of a rudely elliptical form, the m
axis being parallel to the river; it is of considerable extent, covering a
fourteen and a-half square miles, being five and three-quarter m
long by three and a-quarter wide. It is chiefly situated on the right b
of the river, but a small portion extends to the opposite side. It se
to occupy a shallow trough or depression excavated in the older ro
partly in the granitic and partly in the slate belt; the rocks of the ou
covering the junction of those underlyings. The newer rocks are ne
uniform in character and composition throughout, and consist of coarse g
grits and conglomerates combined in the same beds, and abounding
casts of calamites and carbonized impressions of various obscure veget
forms. These rocks are apparently identical with those already descri
as occupying a very large area in the great Carboniferous field ab
the unfossiliferous red rocks; no traces of which are to be found in
outlier, which rises on the right bank to an average height of 420
above the river, shelving with a tolerably uniform slope towards its ban

Although no distinction can be drawn between the sandstone and c
glomerate here, in regard to stratigraphical order, the rocks show stra
cation, and apparently dip at a low angle, on the whole, from the exte
to the centre of the area. It is probable that the mass is of no gr
thickness; for at a point near its centre, and at no great distance fr
that of its highest elevation above the river, a fall on a branch of Jo
lyne's Creek, which has cut thirty or forty feet from the present surfa
into the sandstone rocks, exposes at its base what appears to be a point

e metamorphic slate protruding into the overlying sandstones. Where ese repose immediately on the granite they are found, as in the case served by yourself near Bathurst, to consist chiefly of the debris of the anite in the form of a highly micaceous sandstone, or "as if from the atification and solidification of a layer of disintegrated granite." (See *eology of Canada*, page 452.) A little coal is reported to have been g up in making a superficial excavation in this outlier; but such a fact, ien taken in conjunction with what is known of the general structure, is t sufficient to warrant the expectation of any workable deposit being ınd here. The extent of the outlier on the left bank of the river is tremely limited, not exceeding 200 acres.

At Keswick Bluff opposite the Indian village in King's Clear, the pecu- Keswick bluff. r features of the slate formation are well exposed in a bold and steep ff rising to the height of over 300 feet, close to the bank of the river, and tending nearly two miles in length. Here the alternations of schistose l compact structure in narrow bands, the varieties of cleavage and ıting, and the contortions and plications of the rocks may be ll studied. At the base of the cliff a small patch of the calcareous red ıglomerate appears, being doubtless connected with the area already scribed as having been met with on the opposite side of the river and at mouth of the Keswick.

At Scotch settlement, near the junction of the granite, the quartzite comes harder, the crystals of feldspar larger, and the whole more ferru-ous than is usually observed, and some bands abound with large cubes of ı pyrites. Such characteristics appear to be frequently prevalent in immediate vicinity of the granite; and here, as in many similar cases, I erved that next to the ferruginous bands, and still farther removed from granite, the slates became more or less calcareous.

From Keswick Ridge and Scotch settlement northward as far as the ver Nashwauk the country was not explored, and from its generally low Nashwauk. l flat character, and being still for the most part a wilderness, appears ikely to afford anything instructive. The rock exposures on the Nash-ık are not numerous, and present no features different from what I have eady described, except that at a point about five miles above Stanley, ere the slate and quartzite are much contorted, they are talcoid, ferru-ous and slightly carbonaceous, penetrated in all directions by small ngs of quartz, and by others of a peculiar white earthy mineral probably ind of kaolin.

n ascending Rocky Brook, a large tributary of the Nashwauk, which s the main river nine and a half miles above Stanley, the exposures— the name imports—become more frequent; their general character and vailing apparent attitude, remaining unchanged. At the Stairs, about

two miles from its mouth, the brook falls in a succession of cascades o great height in a rocky gorge overhung by lofty perpendicular cliffs. mediately above this point a small tributary joins the main brook, flo in a south-westerly direction, and about three-quarters of a mile up creek, occur the only fossil forms which, so far as I know, have hith been found in these rocks.

Fossils.

The discovery of fossils at this locality, which is situated in the dept a pathless forest; seldom visited except by the lumberer; was accide The fact of their existence was first brought to light by Mr. Edward J Civil Engineer and Land Surveyor, by whom they were observed in the co of his professional avocations, but who seemed to have been under the pression that they were only drift fossils. Mr. Jack, however, in the aut of 1867, communicated the fact in a short note to the Natural His Society of St. John. Very shortly after my arrival in the Province, heari the matter from Dr. Leith Adams of the 22nd Regiment, then statione Fredericton, who had visited the place, and suspected that the fossils m belong to the underlying rock, I visited the spot in company with him, succeeded not only in obtaining numerous specimens of the loose extremely friable forms which had been previously observed, but in trac them to their parent bed in the solid rock.

The fossiliferous layer, which so far as I could discover, does not exc two inches in thickness, standing nearly vertical, and in conformity with general attitude of the strata, is a hard close-grained argillo-micace and slightly calcareous rock, evidently an indurated shale, scar distinguishable, on unweathered surfaces, from the ordinary s and quartzite of the country, but in the joints and laminæ shewing presence of much iron by a thick brown rusty coating. The entire ro through long exposure, becomes a brown pulverulent mass, and it is to weathering alone that we are indebted for the exhibition of the fossil for many of which are in a sufficiently good state of preservation for identifi tion, and are tolerably free from distortion. Although it is only under s conditions that the forms are visible, the entire mass of the band is proba filled with them.

List of species.

The following is a list of the species which have been recognized a determined by Mr. Billings:—*Chonetes Canadensis*, *Leptocœlia flabelli* *Renssellaria ovoides*, *Strophomena perplana*, *Streptorhyncus* (undeterm ed species). This assemblage of fossils is characteristic of that part of Gaspé limestones which constitute a passage between the Upper Silur and Devonian series. (See *Geology of Canada*, pages 393 and 933).

As the discovery of these fossils is an isolated fact, unsupported by si lar evidence in other parts of the region now under notice, and as relations of the rocks enclosing them to the rest of the formation have not

en fully determined, it would be premature to assign to the whole the me geological age as that established for the fossiliferous stratum above scribed. It seems highly probable, however, that this discovery may ad to some modification of the views hitherto entertained by geologists th regard to the age of this schistose belt, which occupies a very large ea in the Province.

On the same brook, 150 yards above the fossiliferous band, although probly closely adjoining it in stratigraphical order, an exposure of highly rbonaceous black slates appears in the bed and banks ; but as this expore was very limited I could not discover their precise relation to the other ata adjacent. The black slates are soft and fissile, with glossy surfaces, ining the hands when touched, shewing various planes of cleavage, and versed in all directions by thin strings of a peculiar white earthy mineral sembling a sort of clay or kaolin, apparently the same as that mentioned on previous occasion as occurring about five miles above Stanley on the shwauk River.

On the Southwest Miramichi the line which I have marked as the boundy between the granite and the slate, is only applicable in so far as regards e area underlaid by the main band of the former rock. Several smaller tches of granite and gneiss were observed within the breadth assigned to e latter ; but as these were only seen in the bed and precipitous banks the river, I am not prepared to state to what extent they pervade the gged and mountainous country on either side.

I have already, in treating of the Carboniferous rocks of the Miramichi, licated the point, at (Campbell settlement,) at which they overlap the te and quartzite, and have referred to the manner in which the latter ks are apparently affected at the contact of the former. In ascending e river, the slate and quartzite occupy an uninterrupted breadth of six d a-half miles, nearly across the strike, presenting no features different m those already noted in the general description of these rocks, except it the prevailing dip seems to be S. E. at a high angle. Above this nt the course of the river becomes exceedingly tortuous, running for e most part in a deep gorge, and the changes of rock are frequent, hough, in most instances, not sharply defined; thus rendering any attempt exact measurement difficult and unsatisfactory. I shall therefore, on e present occasion, merely indicate in a concise manner the nature, locales and approximate thicknesses of the various descriptions of rock met h. The point of departure from which the distances are estimated is e junction of the two great divisions of the rock formations at Campbell tlement; the distances themselves, and the thicknesses of the various nds being measured in a straight line across the strike of the rocks.

At the point above indicated, near Lower Birch Island, (six and a-half

Mirimichi section.

miles from Campbell,) there occurs what I take to be a dyke, ten or tw feet wide, composed at the surface of a soft brown-weathering, argillac rock with much iron and manganese, apparently cutting the rocks, with a course a little E. of N., succeeded by a band of red and green s about 1000 feet in aggregate thickness, also much stained with oxid manganese, and apparently dipping S. E. <75°. At the mouth of T Brook, (seven miles) a very hard green, highly feldspathic quartzite, wh appears to have the same dip as that above noted. At seven and a- miles, a band of very hard close-grained cherty rock resembling Lyd stone, four feet wide, holding much iron pyrites and imbedded in light gr micaceous and ferruginous slate. At Falls Brook, (seven and three qu ter miles,) there is a band of highly ferruginous soft, black, but rusty-bro weathering slate, the attitude of which is vertical, and the breadth ab 450 yards. The fall is about a quarter of a mile from the main riv the brook running on the strike of the rocks, which, apparently by influences of the weather and the eroding action of the stream, have b excavated into a triangular gorge about 300 yards wide at the main riv with almost perpendicular sides 300 feet high, converging to a point the fall, which has at least 130 feet of uninterrupted descent, present a singularly wild and picturesque scene.

The next tributary, falling in, as nearly all do, on the left bank, Rocky Brook, nine miles from Campbell, between which and Falls Bro occur black and greenish banded or ribboned very hard slate and qua zite, dip S. E. <60° ; then alternating bands of hard purple quartzite a yellowish feldspathic sandstone, resembling a fine-grained imperfec formed granite. These bands, of which there are at least two of each d cription of rock, are from 50 to 100 yards in width respectively, and to S. E. <75°. The quartzite bands are much seamed with quartz vei running north and south, corresponding with the direction of the more co spicuous joints of the granite throughout; and immediately above the alternating bands appears a considerable mass of granite, extending fro one-third of a mile below Rocky Brook upward for one and three-quart miles, succeeded by a breadth of about 400 yards of banded black an green quartzite, resembling that previously noticed.

Then follows an equal amount of ordinary quartzite, still with S. E dip, underlaid by a breadth of 100 yards of highly ferruginous decompo ing quartz rock, in some places resembling an altered conglomerate, form ing a very high steep crumbling bank; giving place, about eleven mile from Campbell, to true granite, extending uninterruptedly to Snake Brook a distance of three and a-half miles, with the exception of one interpose band, not over 300 yards wide, of highly ferruginous quartzite. Betwee Snake Brook and Burnt Hill Brook, a distance of one and three-quarte

iles, the banks are occupied by quartzite dipping N. W. $<80°$, and gradu- ly, on approaching Burnt Hill, appearing to pass into a variety of gneiss, p N. W. $<60°$. The rocks near the mouth of Burnt Hill Brook are cut 7 numerous transverse veins of quartz, holding much iron pyrites and ccasionally a little molybdenite. The direction of the veins, as in the ise formerly cited, coincides with that of the more prominent joints of the ranite, a large apparently isolated mass of which occurs about half a ile up Burnt Hill Brook. Immediately at the mouth of the brook, how- rer, a band of very hard close-grained variegated or ribbanded silicious slate interposed, and probably lies directly in contact with the granite, which arcely makes its appearance on the main river, and seems to thin out a point a little above the mouth of the brook. The aspect and attitude the rocks here would seem to indicate that the granite lies in a synclinal, r immediately above the point last referred to, the gneiss re-appears, ith S. E. dip $<60°$, and sometimes enclosing in its beds masses of ranite, as if detached from the main body and incorporated with the neiss, which gives place again, in ascending, to fine-grained hard com- ict quartzite.

This description of rock continues, and with the same attitude, to Little urnt Hill, one mile higher, where the dip seems again to change to N. 7., and green micaceous schists, with quartz veins holding pyrites, are tercalated. The quartzite continues in bands of varying hardness and olour, and passes near the mouth of McLean Brook, sixteen miles from ampbell, into a very hard black slate rock, standing vertically, and con- nuing, with no perceptible change except that it becomes of a deep bluish nt, as far as Slate Island, where patches containing considerable calca- eous matter, iron pyrites, and traces of copper pyrites were observed. bove Slate Island for one mile no change was noted except the absence lime in the slate; then a band of gneiss 400 yards in width, succeeded 7 feldspathic slates of about an equal amount, and again, at or near the orthern boundary of the New Brunswick Land Company's tract, by eavy bedded black micaceous gneiss. A very short distance above this oint, near McDonald's Brook; seventeen and three-quarter miles from ampbell measured in a straight line across the strike; is the line which have drawn on the maps, as the division between the main granitic area nd the slate and quartzite band.

III. THE CENTRAL GRANITIC AREA.

The distinction noted in the close of the last section, and implied by the tle given to the present, may appear to have been drawn somewhat arbi- arily; for the so-called slate and quartzite band includes, as we have

seen, three very considerable, besides some smaller, bands of grani although the prevailing rock of the section is undoubtedly of the nat designated by the terms used. The region beyond, and on the north-w side of the line referred to, appears to be occupied, for the most part, if entirely, by granitic rocks.

In attempting to define or map the rocks of this region much perplex is occasioned by the gradual manner in which many of the various felds thic rocks seem to merge into each other. Not only does this rema apply to the granite and gneiss, which are sometimes blended in suc manner as to defy all attempts at exact definition; but even the foliated se crystalline slate and quartzite frequently appear to partake of the sa characteristics. In exploring the rocks of this region no evidence was m with of the injection or upheaval of the granite among the stratified roc or of the derivation of the latter from the former. I suspect, howev that, on the whole, the granite will be found generally to occupy a low position stratigraphically than the other rocks.

Granites.

The granite presents great varieties in colour, texture, and in the pr portion of its component minerals. In general the mica is rather sparing diffused, and sometimes altogether wanting, and the feldspar cryst frequently attain a great size, up to an inch and a-half in thickness. Occ sionally irregular fragments of gneiss of all shapes and sizes are foun imbedded or rather incorporated in the granite, and *vice versa;* but appearances of granite veins cutting the laminated rocks are noted. Th direction of the granite band, whether taken as a whole or locally when see in contact with other rocks, coincides with the general strike of the countr It is, however, extremely rare to find such junctions exposed, as th granite, probably from being more readily disintegrated, has suffere more from superficial denudation and atmospheric influences, and conse quently underlies low flat land, except when flanked and protected b more resisting rocks. Within the limits assigned to the main graniti band other rocks sometimes occur, as will presently be seen.

The breadth of this band on the South-west Miramichi, in a direct line is ten and a-half miles, extending from the point already noted to abou half a mile above the forks of the north and north-west branches Throughout the whole of this distance the country is an extensive, level heavily wooded flat, affording no rock exposures, except occasionally a great intervals in the bed and banks of the river. Although other rock may, and probably do, underlie this district, they are entirely concealed and the exposures are uniformly of granite, although not always of the same character. At one place, a little below Lewey's Falls, nineteen

Sandstone,

miles from Campbell, a fine-grained yellowish feldspathic sandstone, resembling that described as occurring near Rocky Brook, is seen for a

nsiderable breadth, succeeded by a thin band in which a multitude of gular fragments of gneiss appear to be enclosed in granite, then by eiss, and làst of all, at the falls, by true granite in massive beds, tending probably to the forks, twenty-six and a-half miles above Campll in a direct line across the strike, through forty-six miles in following e tortuous course of the river, which, throughout the whole distance, is le, deep and rapid, and much obstructed by huge granite boulders. The erage fall I should estimate to be at least eight feet in a mile.

The region lying towards the head waters of the Nashwauk and Becguimic has not been traversed by me, and I am indebted to Mr. Edward ck for such facts regarding it as I have recorded on the larger map, l which I believe may be relied on as authentic.

At Hayneville and Springfield, which are included within the granitic t, and where there are several ridges and hills composed partly of this k, a considerable extent of country is nevertheless underlaid by very rd close-grained ferruginous feldspathic quartzite, resembling petrosilex, l sometimes traversed by great veins of quartz, holding much silvery ca. There is also found in this vicinity, and near the most northerly t of Hayneville settlement, a band of carbonaceous slate resembling t near Rocky Brook on the Nashwauk, its attitude being apparently nformable to that of the adjacent feldspathic and ferruginous rocks; its true relations, as in the case of the Rocky Brook band, have not been accurately ascertained.

On the river St. John the granite band extends from the upper end of eat Bear Island, twenty-four miles above Fredericton by the river nks, to a little below Sullivan's Creek, a breadth of fifteen and a-half es measured in a straight line across the strike. Throughout this eadth the granite is of a very varied character, as before noted with pect to that on the Miramichi. Included bands of gneiss and gneissoid artzite are irregularly distributed, the Meductic Rapids owing their gin apparently to the varying hardness of the rocks; the carbonaceous tes appear to be nowhere represented in this section, unless it be at a nt a mile and a half below the Nackawicac River, where an extremely d jaspery rock, resembling Lydian stone, abuts upon the main river. the right side of the river the granitic region has only been explored me along the bank, and towards the junction of the supposed Carbonious outlier; the limits, however, as provisionally laid down on the ps, are given on good authority.

IV. NON-CALCAREOUS SLATE BAND NORTH-WEST OF THE GRANITE.

This division comprises the rocks underlying parts of the counties of rk and Carleton, extending on the St. John River from Sullivan's

Creek to a point a little above Woodstock, or a breadth of sixteen m and on the Miramichi seven miles, measured in a straight line across strike; from the forks of the north and north-west branches. These present few characters to distinguish them from the band already desc as lying on the other side of the granitic belt, and, in the absenc evidence to the contrary, may be assigned to the same geological age. will therefore be unnecessary, on the present occasion, to enter into detailed description, and I shall proceed to notice a few of the most minent points of distinction which have come under my observation.

Mica-schist. On the St. John River, immediately above Sullivan's Creek, exten about five hundred yards upwards, and apparently in contact with or proximity to the granite, occurs a band of highly ferruginous finely nated mica-schist, traversed longitudinally by large quartz veins, and dip N. W. < 30°–50°. This is succeeded by ordinary clay slate and quart which continues, with many sharp convolutions and folds, but preser the prevailing north-westerly dip at high angles, to Patchell's Ferry, and a-half miles from Woodstock. Here the rocks begin to assun more crystalline aspect, and all around Woodstock afford evidences o

Crystalline rocks. abnormal and disturbed condition. Bands of crystalline rocks, resemb granite, syenite, diorite, (occasionally with trappean rocks) and someti holding epidote, iron and copper pyrites, galena and other minerals, intercalated in the manner of conformable or imbedded masses. Som these I have represented upon the map, but they are too numerous too varied in character, and have not been studied sufficiently in deta admit of an exact description.

I observed isolated patches, generally of no great extent, of an alt slate conglomerate composed of rounded and angular fragments of the rounding rocks, cemented by a feldspathic paste into a hard rock; t are probably lenticular masses occupying depressions in the older ro

Woodstock. About half-way between Upper and Lower Woodstock, on the right b of the river, an interesting exposure of green quartzose and epidotic r jointed so as to present some appearance of columnar structure, occu near the Iron Works the same kind of rock, but devoid of the pecu structure referred to, occupies a considerable breadth; and near Lo Woodstock a narrow band of red and green fine-grained and very regul laminated slate, not over thirty feet in thickness, was observed runn conformably with the general strike, but dipping S. E. < 40°. The w district is exceedingly interesting to the geologist, and especially so in c nection with the deposits of iron and copper ore in the vicinity; but wo require, in order fully to elucidate its structure, a more careful and detai examination than I had it in my power to give.

In this section, a remarkable exception to the general character a

tribution of the rocks, as above described, occurs in the form of an ;ensive outlier of supposed Lower Carboniferous strata, occupying an ea of probably not less than sixty or seventy square miles, chiefly in the rishes of Brighton and Peel, in Carleton county. This outlier has not eviously, been specially described, so far as I am aware. Carboniferous outlier.

On the left bank of the St. John River, opposite Campbell Island, two les below the mouth of the Beccaguimic, a band of conglomerate, 560 rds broad, abuts upon the river. It is here of the character described as longing to the silicious conglomerate band of the main Carboniferous ea ; or rather partaking of a combination of this with the underlying red lcareous conglomerate of the same series, with which, on tracing it to ne distance inland, it becomes completely assimilated. The north-stern outcrop of this outlier, as delineated upon the maps, has been traced me, at intervals, for a distance of twelve miles ; and a partial traverse s been made near the centre to a distance of one and a-half mile ; where S. B. Orser's mill, on the north branch of the Beccaguimic, coarse red ndstone and conglomerate appear to dip N. W. $<$ 27°. For the further formation which has enabled me to trace approximately on the maps the undaries of the outlier, I am indebted to Mr. Edward Jack, who, in the urse of his surveys for timber locations, traversed this region in the fall last year, and at my request, noted any remarkable geological facts which me under his observation. His remarks in reference to this outlier, iich were not communicated to me until after my return to this city, are cessarily somewhat general, although sufficiently explicit to justify me in signing to it provisionally, the limits laid down on the map ; and I consider unnecessary to give them in detail, as you will probably deem this inter-ting field worthy of further special research.

On the right bank of the St. John River, a little below the band of sili-ous conglomerate already referred to, a somewhat similar deposit, but tirely resembling the red calcareous conglomerate and sandstone of the rboniferous series, is displayed to the extent of 1,200 yards in breadth. here evidence of stratification occurs in this deposit, it appears to dip to e north-west in the same direction as the metamorphic slates by which it enclosed on both sides, although at a lower angle. The same band is aceable for seven miles on the strike, extending to the rear of the Wood-ock Iron Works, where it thins out to a point, and terminates about 100 rds south of the Jacksontown Road. This is probably connected with the nglomerate and sandstone area in Brighton, as already described, but re is either brought into position by a dislocation, or occupies a narrow and allow wedge-shaped cavity in the older rocks. The only distinction I n observe between its condition and that of the lower red calcareous con-omerate of the main Carboniferous area ; consists in the fact that here the

rock appears to be affected by numerous small faults or slips, whic maintaining their straight course, have cut through pebbles and m alike.

V. CALCAREOUS CLAY SLATES IN CARLETON AND VICTORIA COUNTIE

Calcareous slates.

The narrow strip or belt of red conglomerate just described, toge with the north-western boundary of the outlier in Brighton, constitute, their continuation on the strike on either hand, the limit of the non-ca reous slates; beyond which to the north-west, without any percept change of attitude or general conditions, commences a set of calcare slates and quartzites, extending on the St. John River, to and far bey the Province line. These rocks, which present a remarkable uniforr in character for very great distances, precisely resemble those which h been described by yourself as occurring and attaining a great developm on Temiscouata Lake and the river Madawaska, and for a great dista down the St. John River, and are in all probability the continuation of same series, which you have determined to be Upper Silurian. The ge ral description of these rocks given in the *Report of Progress* for 1849- page 60, is so concise and graphic, and at the same time, in its m features, so precisely applicable to those now under notice that I may excused for quoting it here.

"The next five miles across the measures are occupied on the west s of the lake by calcareo-argillaceous slates, occasionally interstratified w non-calcareous bands, and some of the beds are more arenaceous th others. The colours are dark bluish-grey, light-grey and black; the divisio of the original bedding are obliterated, and in fresh fracture it is only the colours, the differences of which are often very obscure, that the stra fication can be made out; but the action of the weather and water on t ice-rounded or *moutonnée* forms which come upon the lake, distinct shews the bedding by the unequal wear of the more or less calcareo layers, the one standing out in beads, and the other re-entering in groove The beds are almost universally thin, and the surfaces give a pictorial d play of a vast variety of the most complicated contortions, sometimes folds leaning over each other to the north-west, and sometimes in involv arrangements which it is quite impossible to disentangle or understar without a larger exposure than usually appears. Combined with the conto tions there are often disruptions or dislocations which, however, shew r veins of interposed foreign material; the torn and twisted mass having bee apparently compressed together and become cemented in such a way tha except for the colours or unequal wear, it would never be suspected that i had been disturbed at all. In some parts, however, these contorted rock are cut up by a multitude of small veins of calcareous spar."

have to add to the above description that the bands of non-calcareous rtzite in the region explored by me, although in general conformable, ear sometimes to cut the rocks transversely to their strike; they from eight to thirty feet in thickness, and are usually traversed by ll strings of calcspar. Where they abut upon the river banks the osures are usually more extensive, than at other points, as if, from their rior hardness, they had more effectually resisted atmospheric influences the erosive action of the river. There also occur in this region a few arently isolated patches of limited extent, of more or less pure limestone, Limestones. ably lenticular in form, sometimes of a slaty structure, and sometimes sive. In two instances which came under my observation, where the seemed to have undergone little alteration, I discovered a few obscure l forms which, however, were scarcely visible except on weathered Fossils aces; but which have been recognized by Mr. Billings as Upper rian.

ntercalated with the calcareous slates of this region are some remark- bands of highly ferruginous red and green slates, sometimes traceable great distances on the strike. The first and most important set of e bands is that in which are situated the deposits of iron ore which Iron ores. been mined at Jacksontown, near Woodstock; and which, in their inuation to the north-east, display at their out-crop near the Becca- nic, twelve miles from Jacksontown, very considerable quantities of a lar ore, being an impure slaty hematite. In the Beccaguimic district e are three parallel bands of red and green slates about half a mile t; one of these only, that nearest the river, appears to contain work- deposits of ore. Towards the south-west the Jacksontown band is eable to the boundary line, and far into the State of Maine; where I rved it, near the boundary line, it was charged with iron pyrites. ther band of the red and green argillites is traceable from Flanigan's , in Simonds, to East Glassville, a distance of nearly eight miles, has yielded in some places good specimens of hematite and specular ; it is five and three-quarter miles distant across the strike from the ier. It would seem reasonable to expect that these bands would serve nark the structural arrangement; but as their attitude in every ance where they were observed is vertical, and their association with r bands obscure from want of exposures, I have been unable as yet ake them available for this purpose.

remarkable band of diorite was observed in crossing the road pass- through East Glassville, about two and a-half miles south of Miller's iers. It appears to run in conformity with the slate rocks, and is yards wide where it crosses the road; in its continuation to the north- on the strike, it appears to run into a ridge of considerable elevation

terminating at three miles distant in Garforth Mountain, which is 800 feet high. The succession of rocks observed in the vicinity o diorite band in traversing it from north to south is as follows : 1. C eous slates, being the prevailing rock of the country. 2. Black a very thin band. 3. Diorite band, 150 yards wide, coarsely cryst of a prevailing dark-green colour, with many seams and joints fille calcareous spar, especially towards its junction with ;— 4. Slaty lime eighteen feet thick. 5. Highly ferruginous decomposing calca slate. 6. Another band of diorite of a laminated or gneissoid a and narrower than the former. 7. Calcareous slate, as at the comm ment of the section ; the whole of which is comprised within a breadt exceeding 500 yards, the attitude of all the rocks being vertical.

Diorite bands.

In the region underlaid by the calcareous slates, the soil is, as mig expected, superior for agricultural purposes, to that in which the devoid of lime prevail.

VI. TOBIQUE VALLEY AND TRIBUTARIES.

In the course of my explorations of last season, I undertook an excu up the River Tobique and one of its most important branches, the Se tine, partly with the view of making an examination of the great L Carboniferous outlier there, and partly to visit certain lands which had leased from Government on the latter stream for gold mining purpos

Tobique River.

The Tobique is a large tributary of the St. John, falling into the stream about fifty miles above Woodstock, from the north-east, its ge course thus coinciding with the strike of the rocks of the country. I its source in the high lands constituting the water-shed between the John and the Gulf of St. Lawrence ; one of its main branches, calle Little Tobique, or Left-hand Branch, with a general south-easterly co connects by a short portage with the Nepisiguit flowing, into the Ba Chaleurs ; while the other or Right-hand Branch, falling into the r river at the same point, but from the opposite direction, through a rugged and mountainous country, is, in its turn, composed of two branc the Campbell and Serpentine rivers. These streams form a junctio the distance of ten miles from the main forks, from which point the bique flows through a rich and fertile valley in a south-westerly dire to join the St. John River, a distance of sixty-two miles, following windings of the stream. On the Serpentine, which had not previou so far as I am aware, been visited by any one with the special vie ascertaining its geological features, the land leased for mining purp commences about three miles from its junction with the Campbell Ri and extends some twenty miles higher, the stream for the greater par

Serpentine River.

distance cutting across the strike of the rocks; but, owing to the
:eme difficulty of exploring this region, I was compelled to content
self with penetrating about seven miles from the commencement of the
ed lands, or twenty miles from the main forks of the Tobique.
The main Tobique, for about two miles from its junction with the St. John,
s with great rapidity through a deep, rocky gorge, its course nearly
nciding with that of the slates, which dip N. 70° W. <60°; they are
e highly calcareous, and enclose many seams and bunches of pure calc-
r. Half a mile higher a narrow band of red and green slate occurs,
ociated with a tolerably pure compact or massive limestone, containing
ils, apparently in considerable profusion, although only visible on weath- Silurian fossils.
d surfaces. Among them, according to Mr. Billings, are *Favosites
thlandica*, *Atrypa reticularis*, and *Strophomena perplana*, belonging
he Upper Silurian series. Above this the river assumes a course
rly at right angles to the strike, cutting sparingly calcareous but highly
uginous and contorted brown-weathering slate and quartzite, which
st underlie those formerly referred to as prevailing at the mouth of the
r. Small straggling strings of galena were observed at one place filling
cks in the rock, but are of no economic importance, except as indicating
metalliferous character of these rocks. At three and a-half miles from
mouth, measured in a straight line on the strike, the soil assumes a red
from the proximity of the red conglomerate of the outlier; a small patch
which is visible in the bank here, but is again succeeded by the older
ks, till reaching Red Rapids, four and a-half miles up, where this for-
ion; apparently identical in character with that mentioned in other
ts of this report as the lowest rock in the Carboniferous series; Carboniferous series.
ears in force in the bed and banks of the river, dipping due E. <4°,
ending over half a mile further up stream, and forming a steep, rocky
nnel.

Above this point the rock exposures are few, and for a distance of nine
a-half miles indicate no change, except in the prevalence of finer red
careo-arenaceous sediments in ascending. Then, about half a mile
w the Wapskehegan, appear red, grey, and green marls, interstratified
n blue limestone, all in thin alternating bands, still dipping slightly
E., and extending to the mouth of that tributary; a little above which
limestone re-appears in more massive beds, some being thirty inches Marls and lime tone.
k, interstratified, as before, with red shales or marls, also of greater
me. This is a distance, in a straight line, of fourteen and a-half miles
n the mouth of the river, and here the outlier attains its greatest
dth, of about nine miles, of which by far the greatest proportion lies
he south-east side of the river. The general character of the limestone
he Tobique outlier is fine-grained, with conchoidal fracture, mottled red

or pink and green, but sometimes bluish-grey; frequently seamed calcareous spar, and containing, according to Professor Hind's anal 82.6 per cent. of carbonate of lime.

Gypsum.

Superimposed upon the limestone and marl beds here, are heavy be gypsum, which first appear at the mouth of the Wapskehegan, but in n greater development at Plaster Cliff, a mile and a-quarter higher; wh for a distance of 80 or 100 yards, they rise perpendicularly from the bank to a height of 120 feet. The great body of the rock is an imp massive but earthy and exfoliating red and greenish gypsum, containi varying proportion of carbonate of lime and silicious matter; but seamed with layers of pure white gypsum and of fibrous selenite, con ing, according to the analysis of the late Dr. Robb, 77.7 per cent sulphate, and 3.0 per cent. of carbonate of lime. Nodules of nearly p carbonate of lime are occasionally met with, imbedded in the red gyps The whole appears to dip S. E. at a very low angle, and to be of lim extent, where it abuts upon the river; but I am informed, on compe authority, that the plaster beds are traceable at least four miles up Wapskehegan, alternating with the other rocks of the series. Two s brooks were observed flowing into the river near the junction of the gyp and marl beds, the waters of which were decidedly saline and bracki this character being, doubtless, derived from salt springs, which howe were not met with.

Amygdaloids.

Above Plaster Cliff, for a distance of eight miles, the strata, which now horizontal, consist, as before, of grey and red sandstone and con merate, blue, red and green limestone, and marl; thereafter, at the p indicated, near Phillips's Brook, promontories and low knobs of dark br amygdaloidal trap appear at intervals among the red rocks on the bank, becoming more numerous and extensive in ascending the ri The red rocks, however, continue to occupy exclusively the bed and ri bank of the river, and occasionally also appear on the left bank, but with westerly dip, until a point thirty-one and a-half miles from the mo is reached, where the outlier may be said to terminate; although for last three miles of this distance, or from Blue Mountain upwards, c slight traces of its existence can be detected in the red colour of the ro in the bed of the river, where they are at rare intervals seen in pla Thus the total length of the outlier, measured in a straight line, may stated at twenty-seven miles; it is of a rudely elliptical form, and its to area is not less than 190 square miles. It is bounded on all sides by f ruginous and generally non-calcareous contorted slates and quartzite, outlines forming a very marked topographical feature, being defined every direction by lofty ridges of the older rocks. A comparison of t rocks of the outlier, both in respect to their mineral character and appar

er of sequence, leaves little room to doubt that they belong to the same es which I have described as lying at the base of the main Carboniferous a of the Province.

Blue Mountain. 3lue Mountain, rising with a steep slope immediately from the bank of Tobique, fifty-one miles from its mouth, as measured along the winds of the river, attains a height of 1,641 feet above the sea, and displays red rocks towards its base. It was not ascended by me, but from its con- r and surrounding conditions, seems to be composed mainly of eruptive ks, of which a great variety, probably detached from its sides, are wn in boulders and pebbles in the bed of the brook which bears its ie. The same description of rocks, offering many varieties of colour texture, occupy the left bank of the Tobique for over three miles above last mentioned brook, and have apparently altered the red sandstone conglomerate of the outlier into a hard jaspery rock. At Riley Brook, ty-four and a-half miles in a straight line from the St. John, light en very soft non-calcareous clay slates are displayed, but only to a ted extent, succeeded by the same hard highly feldspathic brown- thering contorted slate and quartzite already so frequently referred to, nding to, and for an unknown distance beyond, the main forks of the ique, and within three miles of those of the Campbell and Serpentine rs. This character, in fact, seems to be generally prevalent here over ery large tract of country, and does not appear to differ in any impor- particular from that which I have described in reference to Sections and IV, into which I have divided the region explored by me.

Eruptive rocks.

Bald Mountain. ome of the highest mountains in the Province are situated in the remote on and among the rocks now under review. I ascended one of these, ed Bald Mountain, which I found to be 2,060 feet above the sea, or 35 feet above the Tobique at its nearest point. It stands alone, in the st of a comparatively level country, the distance being five miles from the ique and about the same from the Right-hand Branch. The mountain, base to summit, is nearly conical, its sides sloping at an angle of 35° ne horizon. The rock, wherever exposed, consists of a very hard fer- nous feldspathic quartzite in massive beds, weathering to a brownish- e or cream colour, dipping N. W. $<65°$; no change either in the re or attitude of the rocks was observed from base to summit.

oft ferruginous slate and quartzite, some of the bands of which are highly areous and contain impressions resembling fucoids, are seen a little e the main forks of the Tobique, with north-westerly dip $<60°$; above ch, in ascending the Right-hand Branch, and for a distance of four a-half miles, measured in a straight line across the strike, heavy- led greenish yellowish-white and brown-weathering quartzites, some- s very slightly calcareous and pyritiferous, occupy both banks of the

river, rising in abrupt cliffs to a uniform height of 600 or 700 feet, res
bling an artificial embankment. About five miles from the main fork
the Tobique, and the same distance from those of the Campbell and
pentine rivers, the lamination, and probably also the dip of the r
changes to S. E.; and a band of excessively hard and tough silicious r
resembling petrosilex, and exhibiting a tendency to columnar struct
crosses the river, forming a fall of moderate height. This is precisel
the line of strike from Bald Mountain, about five miles to the south-we

About three miles higher up the branch a high ridge, running als
the direction of the strike, abuts against the river, with apparently a s
lar nucleus of hard rock, which, however, in this case, resembles som
the red trappean rocks described as occurring near Bald Mountain in
County, at the base of the Carboniferous series. This ridge deflects
course of the river sharply to the north-east, about the forks of the Ca
bell and Serpentine. At a point called Salmon Hole, where the
trappean rock first makes its appearance on the bank of the river, a nar
band of soft green argillaceous slates, with glossy surfaces, occurs, sea
Metalliferous veins. with numerous small lenticular veins of quartz, carrying iron pyrites an
little galena, and said also to yield some silver. The breadth of the
red rock, which, however, seems to include some narrow bands of sl
does not exceed half a mile; it is followed, at the forks of the Serpen
and Campbell, by light green quartzite devoid of metalliferous indicati
dipping N. W. This continues, with interruptions from two narrow b
of the red and dark green glossy rock, for three miles up the Serpent
where the mining leases commence, at a point where traces of copper pyr
are said to have been seen in dark grey contorted slates seamed with qu
veins, and resembling those on the St. John River, a little below Wo
stock. Two miles higher a band of yellowish-red trap, or other hard ro
again deflects the course of the river sharply to the north-east; and a m
beyond this point, or six miles from the forks, a band of highly pyrit
slate appears, followed by light grey micaceous schist, with much inte
minated quartz, or rather a mixture of quartz and slate, in which gold
said to have been found. The breadth of this band is uncertain, tho
probably not great; it is succeeded by a compact quartzose and felds
thic rock resembling petrosilex, showing no traces of metallic minerals,
sometimes of a feebly laminated structure, resembling gneiss; and wh
gives place, at a distance of eight and a-half miles from the forks, t
band of granite not exceeding 600 yards in width, over which conside
able fall in the river occurs; and above this the same alternations of gne
and quartzite which were observed below the granite band, but with
the talcoid and pyritiferous slates. This was the limit of my observati
in this region.

ECONOMIC MINERALS.

To this branch of the subject I have alluded incidentally in describing rocks at the various localities where minerals capable of such applicans exist, or are supposed to exist. From a very early period in the tory of this Province, much has been said and written regarding its neral wealth, both in coal and the metals; and capital has been to some ent employed in the development of its mineral resources, although s to be regretted that hitherto the success which has attended such tures has not been very marked. My own observations have not been de with any very special reference to this subject, but, in so far as y have been directed to it, I confess that I have been somewhat disapnted, both as regards the probabilities and actual results. Mere ications of valuable ores or minerals are insufficient to constitute a mining ion; and the failure of operations undertaken on inadequate grounds s as a check upon others which may have a legitimate basis, and tends etard rather than promote the mining interests of the Province.

Vith reference to the small portion of the Carboniferous area examined me; I have already given my views as to the futility of any expectation he occurrence of workable coal seams in these rocks ,which are altoner below the productive coal measures. The sandstones are in general coarse-grained and too ferruginous to make a good building material, ough some of the beds of purple sandstone appear well adapted for such poses. In some places I found them tolerably well suited for grindes, flags and tiles. The red marls towards the base of the series may available as a pigment, where free from silicious matter; and excellent k clays, some of which seem also to possess the qualities of fuller's h, abound.

n the metamorphic rocks of this region the first mineral of economic ortance which claims attention, is antimony. The antimony mines of Antimony. ice William have been worked at intervals and to a small extent for six even years at three adjoining locations situated twenty-four miles from dericton and three miles from the Woodstock road. The rock of the ntry is talcoid slate and quartzite, coinciding in strike and dip with generally prevalent throughout the section. The mines are in the ediate vicinity of the supposed Carboniferous outlier of Prince William, within two miles east of the junction of the slate and granite. The s, which have been partially developed by mining, have the character ue or fissure veins cutting the rocks, and thus may be expected to e persistent in depth. Two of them have a course nearly parallel, and e distance of about one hundred feet apart, underlying due N. < 45°— while the third has a bearing exactly at right angles to these,

and underlies to the E. < 43°. In the former cases the matrix is sla and quartz, without any admixture of calcareous spar, while in the latter considerable amount of this mineral is found in the vein. The ore stibnite or sulphuret of antimony, occurring both in pure solid masse and more or less mixed with the gangue. The thickness of the vei which is nearly the same at the different locations, varies in the same sh from four to twenty inches. In so far as hitherto developed, the best c and the thickest part of the veins have occurred within fifty feet of t surface. On the vein first worked the shaft has been sunk nine feet, and ten tons of ore sent to market. At the second the shaft is t hundred feet deep, and drifts have been carried to the aggregate length four hundred feet; ore to the amount of one hundred tons was obtaine of which thirty tons have been sold. At the third, which was in operati at the time of my visit, the shaft is sunk two hundred and eight feet, a seventy or eighty tons of ore had been obtained, some of which was sa to contain a considerable proportion of silver. I must add that two spe mens taken by me, for assay by Dr. Hunt, have shewn no traces of silv although this may be no conclusive proof that it does not exist in so part of the vein.

Molybdenum.

In the account which I have given of the section of rocks exposed on t South-west Miramichi, I have mentioned the occurrence, near the mou of Burnt Hill Brook, of sulphuret of molybdenum in thin quartz veins gneiss. Some of the veins at the surface are charged with the mineral thin foliated hexagonal plates. This mineral has found some importa applications in the arts, chiefly for the production of a dyeing mater and as a re-agent in the laboratory. It is somewhat rare, and t price was quoted in the Paris Industrial Exhibition of 1855 at $3.45 p lb., (see *Geology of Canada*, p. 755). It is doubtful, however, if any the veins visible at the surface at the locality named, which is remote a not easily accessible, will yield a sufficient quantity of the mineral to rep the cost of mining and sending to market.

Copper.

About three miles below the town of Woodstock, on the right bank the St. John, veins of yellow sulphuret of copper, associated sometin with much iron pyrites, occur at several points in the vicinity of an ap rently stratified mass of rock resembling diorite, but holding a sm proportion of quartz. These veins have attracted attention from a ve early date in the history of the Province, and have formed the object mining enterprise on a considerable scale, but were abandoned seve years ago as unprofitable. The veins opened, though tolerably promis at and near the surface, were not found to maintain that character sinking. In the rock cutting on the railway, about a mile below Wo stock, is a bed of light green or grey highly altered epidotic slate, c

rmable with the stratification, and resembling that near the Iron Works, contact with which is a band of chloritic slate charged with iron pyrites d galena, and near to this a conglomerate similar to those formerly scribed as seen at the mouth of the Meduxnakeag. I found among the ingle on the bank of the river St. John, seven miles below Woodstock, large boulder of rich copper pyrites in a matrix of slate conglomerate. though, so far as yet known, the copper ore in the vicinity of Woodstock es not occur in true veins, masses of the character described, when of ficient magnitude and richness, have been profitably worked in other rts of the world, and such may yet be brought to light here.

The iron ore of Jacksontown, three and a-half miles north-west from Iron ore. oodstock, has attracted much attention from an early period, having en first noticed by Dr. Jackson in his Report on the Geology of Maine, 37, and has been treated at various times in the smelting furnaces Upper Woodstock, about the same distance from the mines. The ore is impure slaty hematite, containing on an average 46 per cent. of the roxide of iron, equivalent to 32 per cent. of metallic iron ; it also contains ariable proportion of oxide of manganese, to which the iron probably es some of its peculiar qualities. It occurs irregularly imbedded in red d green clay slates, and it is thus impossible to assign any specific or inite thickness or length to the deposits ; enough, however, is known to tify the assertion that the ore may be found in very great abundance. at hitherto obtained, which has been extracted altogether by the method open cuttings, and smelted at the Woodstock Iron Works, amounts to ut 40,000 tons ; many of the bunches of ore have been worked out at epth of from twelve to twenty feet from the surface ; some, however, seem be connected with beds or courses, probably of greater regularity and tinuity and of richer quality. In one of these (Carnie's mine), where ch quartz was associated with the bed, and some of the ore was of the cular variety, I found small portions of purple copper ore.

The pig-iron produced from the Jacksontown ore is remarkable for its at hardness and strength, and when mixed in certain proportions with er kinds, has been found very advantageous for railway car-wheels. ien converted into wrought iron, it is said, on the authority of Mr. Fair-rn of Manchester, to be specially suited for the plating of iron-clad war sels and similar purposes, where a combination of great hardness and acity are requisite ; it is also said to be admirably adapted for the manu-ture of steel. The fuel used for smelting the ore at the furnaces, which Woodstock furnaces. e not, however, in operation at the time of my visit, is wood charcoal ; which 126 bushels, together with about 3¼ tons of ore, were con-ied to make one ton of pig iron. The cost of the fuel and the somewhat produce of the ore have hitherto retarded the vigorous prosecution of undertaking which otherwise seems to possess the elements of success.

Similar ores occur, apparently in the same band of rocks, and in gre abundance, near the River Beccaguimic, and also, although probably not abundantly, in a parallel band running from Flanigan's Hill on the St. Joh toward East Glassville settlement. If found economically available other respects at either of these places, they will possess an advantage the proximity of forests, from which a supply of fuel could be derive

Gypsum and limestone.

The deposits of limestone and gypsum on the Tobique, already describe are practically inexhaustible and easily accessible; and although their colou and the admixture of foreign constituents might render them unsuitable f building and decorative purposes, they are well adapted for use in agricu ture. These deposits are in the supposed Lower Carboniferous rocks. A several points also in the calcareous slate band between Woodstock and th Tobique, as at Pole Hill, Windsor and Glassville settlements, the bank the St. John River in Peel parish, and two and a-half miles up the Tobiqu bands or more or less extensive lenticular masses of limestone, sometim fossiliferous, occur, which may advantageously be burnt in kilns, an employed for general purposes. As a flux for the smelting of iron or that from Pole Hill has been quarried and conveyed to the Woodstoc furnaces; but I understand that the deposit on the St. John River in Pee about four miles above the Beccaguimic, which has latterly been employe is preferred, as it is said to contain less magnesia than the former.

The geological conditions in the north-western part of New Brunswic being by many supposed to be analogous to those of auriferous countri generally, and more particularly of Eastern Canada and Nova Scotia, is not surprising to find that, from an early period, hopes and expectation should have been entertained that it might prove a gold-bearing regio and these have been from time to time confirmed by reported actual di coveries of the precious metal.

Within the past two years, and since the Canadian and Nova Scotia gold mines have begun to attract increased attention, attempts have bee made on a small scale, both by alluvial washings and by explorations in th supposed gold-bearing rocks, to realize these hopes. The results in bot cases, so far as I have had the means of judging, are moderately encoura ing; but it would require the expenditure of a larger amount of capit than has hitherto been applied in order to establish the *profitably aurife ous* character of the region. In the few places where sluicing has bee tried, and that only on a rude and tentative scale, the conditions appear t have been unfavourable, owing either to the absence of the older drift clays which are supposed to be more especially gold-bearing, or to their being to far below the drainage level to be accessible without special and expensiv appliances for pumping, etc.

With regard to gold in the rocks, although rumours are current o

spectable authority to the effect that pebbles and boulders enclosing a tle of the metal have been picked up in various localities, I am not aware any well authenticated instance of gold being found in a vein. On the Serntine and Campbell rivers, and on the Wapskehegan, tributaries of the ibque, where the rocks are supposed to be more especially favourable to e existence of gold, and where chiefly the auriferous pebbles are reported have been found, mining leases have been taken up, but very little work ne. I made a cursory examination of part of the lands leased for gold ning on the Serpentine; and although the rocks, as I have described em in another place, seemed to be of a favourable nature and condition, ecimens of quartz which I took from what were considered the best spots re, as well as from several other places which I deemed worthy of trial, ve yielded to careful assays by Dr. T. Sterry Hunt, neither gold nor ver.

The conditions both of the rocks and veins here appear to me to resemble ose in the Chaudière district in Quebec, where the quartz veins are ticular, interrupted, and only in exceptional cases yield gold; rather an those in the gold districts of Nova Scotia, where they are more regu- and persistent, and very generally auriferous to a greater or less extent. e fact that no gold has been found in the specimens taken by me, by no ans militates against the possibility of its being found in other specimens d at other localities in the region.

I have the honour to be,

Sir,

Your most obedient servant,

CHARLES ROBB.

REPORT

OF

T. STERRY HUNT, LL.D., F.R.S.,

CHEMIST AND MINERALOGIST,

ADDRESSED TO

SIR WILLIAM E. LOGAN, F.R.S., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

MONTREAL, November 1, 1869.

SIR,—The subjects embraced in the Report which I have now the honor submit to you, have already been mentioned in your summary Report the Government, dated May 1, 1869, and are still farther indicated in e table of contents prefixed to the present volume. They include:

I. Investigations into the geology and chemistry of the salt deposit of the Goderich region, and a discussion of the best modes of manufacturing salt, considered with reference to our own resources.

I. Studies upon the iron ores of the Dominion and the best modes of working them. These investigations it is proposed to continue in a subsequent Report.

I. Mineralogical notes on the occurence of gold, silver and bismuth ores in Hastings county, with analyses.

I. THE GODERICH SALT REGION.

In the Report which I had the honor to submit to you in 1866, there ll be found, on pages 263–272, an account of the salt deposit then cently discovered by boring, at a depth of 1,000 feet from the surface, ar the town of Goderich, in Ontario. As regards its geological position, was there shewn from the results of the boring that the Onondaga forition attains in that region a thickness of about 1,000 feet, of which the ver 200 feet consist of reddish and bluish shales, including beds of gypm, and near the base a layer of rock salt, which in the Goderich well s said to have a thickness of about forty feet, including some layers of ie clay. From this depth there was obtained, by pumping, a saturated

brine, my analysis of which was given. Attention was in this Repor called both to the strength and the remarkable purity of the brine, an comparative results were given to show its great superiority over the brine of Saginaw in Michigan, and of Syracuse in New York. A table show ing the strengths of brines of different specific gravities, and the number o gallons required for a bushel of salt, was also given in this connection. I is deemed advisable, however, to give in the present Report a more extende table of the same kind, which is reprinted from Professor Alex. Winchell' Report on the Geology of Michigan, published in 1861.

Since the publication of that Report, the well then described, whic belongs to the Goderich Company, has been constantly pumped, and larg quantities of salt have been manufactured from the brine. Encouraged b the success of this well, several other borings have been sunk in the imme diate vicinity, and are yielding brines like the first one. The record o all these wells is essentially the same as that of the first. The presence c a stratum of rock-salt has been established by the grains of salt brought u by the sand-pump from the borings. In the course of 1867 Mr. Ransfor
Clinton. sunk a well at Clinton, thirteen miles to the south-east of Goderich, on th line of the Buffalo and Lake Huron railway, and was rewarded by th discovery of the salt-bearing stratum, offering, it is said, a thickness c sixteen feet of rock-salt. The depth of this well is 1180 feet, and th greater thickness of rock overlying the salt at Clinton is due to the south eastward dip of the strata; from which it results that the summit of th Onondaga formation, which appears at the surface at Goderich, is a Clinton covered by about 200 feet of the Corniferous limestone. Thi overlying formation occupies, to the north of Goderich, a broad triangula area extending north-eastward nearly forty miles, and bounded to the north east and north-west by the out-crop of the underlying Onondaga formation

Kincardine. Upon this latter, at Kincardine, thirty miles north-east of Goderich another well was sunk last year, and showed the existence of the salt-bearin stratum at a depth of about 900 feet. The record of the boring furnishe me was as follows:—

	Ft. I
Sand and gravel	91
Limestone and hard strata	508
Red shale	23
Blue shale with a red band	117
Limestone	30
Blue and red shale, partly very soft	125
Rock salt	13
	909

By comparing the above result with that obtained in the first well at oderich, it will be seen that while the amount of shaly strata from the base the limestone to the bottom of the salt was only 205 feet at Goderich, it ains at Kincardine a thickness of 309 feet; in which, however, are luded thirty feet of a rock described as limestone, but which may rhaps be gypsum, masses of which were encountered in the shales in ring at Goderich. Of the 775 feet of limestone belonging to the forma- n at Goderich only 508½ remain at Kincardine, the upper portion being noved by erosion. It is not, however, certain that the original thickness he Onondaga, or Salina formation as it is sometimes called, was precisely same here as at Goderich, and thus the amount which has been noved by erosion may be somewhat greater or less than would at first ear. In like manner, the thickness of the same formation at Clinton y differ somewhat from that at Goderich, so that the overlying portion Corniferous limestone at that place may be greater or less than 200 , according as the volume of the Salina formation is less or greater n at Goderich. Careful examinations of future borings would enable us etermine these important points, and for this end samples of the material acted at intervals of fifteen or twenty feet, should be carefully preserved.

he base of the Onondaga formation comes to the surface at the mouth he Saugeen river. Here, at Southampton, an ill-advised attempt was year made in search of salt by boring. According to the record ished me, the solid rock was only reached at a depth of 230 feet,* after h 350 feet of white and gray limestone had been penetrated up to ust 22, 1868. The subsequent record is incomplete, but beneath the stones were encountered several hundred feet of red shales, and the g was finally abandoned at a depth of 1,251 feet from the surface. ther well also was sunk last year at Port Elgin, five miles below South- on, on the coast, and the boring in November last, had attained a n of 890 feet, and was still going on in the red shales. In this connec- may be noticed a well which was sunk in 1867, at the village of erloo, about eighty miles to the south-east of Port Elgin, but in the geological position, that is to say near the base of the Onondaga

Southampton.

Port Elgin.

Waterloo.

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ne account of this portion of the boring is as follows:—

ravel and sand, with trunks of trees at the base	23½	Feet.
ard-pan and boulders	36	
lue clay	5	
oarse sand and gravel	16	
ard-pan and boulders	4½	
oft marly beds	50	
ue clay with boulders	67	
ard-pan and boulders, with gravel	28	
	——	230

formation, and was abandoned at the depth of 1,120 feet. The record
the boring was as follows :—

Superficial clays and gravels*		130 F
Limestone	40	77
Gypsum	17	
Shale	20	
Limestone, gray and white		340
Blue shale		114
Red shale		459

Bitter water.

At this depth the well was abandoned ; bitter saline waters were met
at depths of 800 and 900 feet, and were probably similar to the bi
water found at St. Catherines at the same geological horizon. In
Report for 1866, on pages 271, 272, the waters of this class are noti
and their unfitness for the manufacture of salt pointed out. The 77
of limestone, gypsum and shale in the Waterloo section belong to the
of the Onondaga, or salt-bearing series, beneath which no valuable br
have yet been found. The 340 feet of limestone underlying the sh
represent the Guelph, Niagara and Clinton formations, and the red and
shales beneath these belong to the Medina formation. By referring t
account of a boring at Barton, near Hamilton, it will be seen that t
shales have there a total thickness of about 600 feet. (Report for 1
page 251).

Onondaga and lower rocks.

It will be noticed that the Onondaga formation, as shewn in the bor
of Goderich and its vicinity, consists of several hundred feet of limes
chiefly magnesian, underlaid by two or three hundred feet of red and
shales, which carry rock-salt at their base. These are succeeded
descending order, by the magnesian limestones of the Guelph, Niagara
Clinton formations, which rest upon the red shales of the Medina, as
in the Southampton and Waterloo borings. We have the following su
sion in going downwards :

1. Limestones of the Onondaga or Salina formation.
2. Red and blue shales of the same.
3. Limestones of the Guelph and Niagara formations.
4. Red and blue shales of the Medina formation.

Mistakes in boring.

On account of the resemblances in color between the upper and l
couples of the above series mistakes may easily occur, as at Southam
where the strata of 3 and 4 were supposed to be those of 1 and 2.
errors, which have caused the expenditure of considerable sums of mon
Southampton, Port Elgin and Waterloo, would be avoided by a ca

* For a notice of the superficial deposits of this region, see the *Geology of Canada*
897.

ly of the distribution of the various geological formations of this region, described in the *Geology of Canada.* The accuracy with which the its of the various formations throughout this region were traced out by . Alex. Murray, has received repeated confirmation in the course of the ious explorations for oil and salt which have been made within the past years.

Extent of salt basin.

As regards the possible extent of the salt-bearing area now under con- eration, I take the liberty of quoting the following passage from my port for 1866, page 271:—

" With regard to the probabilities of obtaining salt wells by other ings in this region, it is to be remarked that the thickness of the depo- of salt traversed in the Goderich well may warrant us in expecting that area may be considerable; though whether its greatest extent will be nd, or beneath the waters of the lake, can only be known by experi- it. It has already been explained that salt deposits have been formed asins whose limits were determined by the geographical surface at the e; and it is worthy of remark that both here and in New York the salt osits are connected with a thickening of the Onondaga formation, ch, in its thinner intermediate portion, is apparently almost destitute alt; a fact suggesting former geographical depressions, in which the two -bearing portions of the formation may have been deposited. Although ould be unsafe to predict that this development of salt at the base of Onondaga formation is so widely extended, its thickness at Tilsonburg, Mary's, London, and Enniskillen, is such that it seems probable that her borings in these localities, where deep wells have already been k, may reach saliferous strata capable of yielding valuable brines."

n confirmation of the first portion of the above extract, we can now point he existence of salt at Clinton, thirteen miles to the S. E., and at Kin- line, thirty miles N. N. E. of Goderich. These two stations are forty s apart, and a line connecting them would pass about seven miles to east of Goderich. It is, therefore, extremely probable that the whole on between Clinton and Kincardine will be found underlaid by salt, may belong to a single basin, whose extent yet remains to be rtained.

he success of the borings at Goderich and in its vicinity has, as we e seen, led to the sinking of wells for brine, below the salt-bearing zon. At the same time, other trials have been made in the hope of hing it, by boring through rocks overlying those of the Goderich region. the information of inquirers, it may therefore be well to recall briefly e of the facts with regard to the nature and thickness of these rocks, which the details are given in my Report for 1866. It will there be that the most recent rocky strata in south-western Ontario are the

Portage formation.

greenish sandstones of the Portage formation. These pass downwa
into hard black slates (the so-called Genessee slates) which, in their t
rest upon the soft gray strata of the Hamilton formation. This grou
sandstone and hard shale, which appears at the surface at Kettle Poir
Bosanquet, and also in Warwick, is generally concealed by the clays of
region; but from the records of numerous borings, chiefly made in sea
of petroleum, we have been enabled to determine its thickness in m
places. Thus, in a boring at Corunna, on the St. Clair river, near Sar
it measures 213 feet; in two borings in Camden, 146 and 200
Sombra, 100; in Alvinstone, eighty feet; in Warwick, and near Wyon
station, about fifty; a little north of Bothwell, about eighty; and fur
south, towards the shore of Lake Erie, about sixty feet in thickness.
will be understood that this varying thickness is due to the ero
along the anticlinals, before the deposition of the clays, so that in m
parts of the region only the lower portions of the black slates remain, w
in other places they are entirely wanting.

Hamilton formation.

The hard strata just described are conformably underlaid by thos
the Hamilton formation, which in some parts of New York attains a th
ness of 1,000 feet, but is reduced to 200 feet in the western part of
State. It consists, in Ontario, chiefly of soft gray marls, called soapst
by the well-borers, but includes at its base a few feet of black b
probably representing the Marcellus shale. It contains, moreover, in s
parts, beds of from two to five feet of solid gray limestone, holding silici
fossils, and in one instance impregnated with petroleum; characters wh
but for the nature of the organic remains, and for the associated ma
would lead to the conclusion that the underlying Corniferous limestone
been reached. The thickness of the Hamilton formation varies in differ
parts of the region under consideration. From the record of numer
wells in the south-western portion it appears that the entire thicknes
soft strata between the Corniferous limestone below and the black sl
above, varies from 275 to 230 feet, while along the shore of Lake Eri
is not more than 200 feet. Further north, in Bosanquet, beneath the bl
shale, 350 feet of gray shale were traversed in boring, without reach
the hard rock beneath; while in the adjacent township of Warwick, i
similar boring, the underlying limestone was reached 396 feet from
base of the black shales. It thus appears that the Hamilton shale (includ
the insignificant representative of the Marcellus shale at its base) augme
in volume from 200 feet on Lake Erie to about 400 feet near to La
Huron.

Corniferous formation.

The Hamilton formation, as just defined, rests directly upon the so
non-magnesian limestones of the Corniferous formation. The thickness
this formation in western New York is about ninety feet, and in sou

tern Michigan is said to be not more than sixty, although it increases going northward, and attains 275 feet at Mackinac. In the townships Voodhouse and Townsend its thickness has been found to be 160 feet; for a great portion of the region in Ontario underlaid by this formation, so much concealed that it is not easy to determine its thickness. If may conclude from the boring at Clinton, it would seem to be in that lity not far from 200 feet. In the numerous borings which have been k through this limestone, there is met with nothing distinctive to mark separation between it and the limestone beds which form the upper of the Onondaga or Salina formation, and consist of dolomite, alterng with beds of a pure limestone like that of the Corniferous formation. saliferous and gypsiferous soft magnesian marls, which form the lower of the Onondaga formation are, however, at once recognized by the ers, and lead to important conclusions regarding this formation in ario.

t Tilsonburg, a boring showed the existence of the Corniferous lime- e directly beneath about forty feet of clay, while in another boring, it two miles to the south-west, it was overlaid by a few feet of soft es, probably forming the basis of the Hamilton formation. The first ng at Tilsonburgh, as mentioned in the report for 1866, was carried depth of 854 feet in the solid rock. Numerous specimens of the ngs from the first 196 feet, were of pure non-magnesian limestones, but w that depth similar limestone alternated with dolomite. The marls h occur at the base of the Onondaga formation were not met with in boring, though the water from 854 feet was said to be strongly saline. s informed by the proprietors, Messrs. Hebbard & Avery, that the well ished, by pumping, a brine marking from 35° to 50° of the salometer, I was not able to get any of the water, and the well was soon after doned, although the presence of so strong a brine would seem to show proximity of a saliferous stratum. Tilsonburg.

a boring at London, where the presence of the base of the Hamilton marked by about twenty feet of gray shales, including a band of black schist, overlying the Corniferous, 600 feet of hard rock were passed ugh before reaching soft magnesian marls, which were penetrated to depth of seventy-five feet. Specimens of the borings from this well, from another near by, carried 300 feet from the top of the Corniferous, that pure limestones are interstratified with the dolomites to a depth 00 feet. At Tilsonburg a pure limestone was met with at 524 feet the top. London.

t St. Mary's, 700 feet, and at Oil Springs in Enniskillen, 595 feet of stone and dolomite were penetrated, without encountering shales; in another well, near the last, soft shaly strata were met with at St. Mary's. Enniskillen.

about 600 feet from the top of the Corniferous limestone, there overl by the Hamilton shales. It thus appears that the united thickness of Corniferous formation and the solid limestones and dolomites which co pose the upper part of the Onondaga formation, is about 600 feet London and Enniskillen, and farther eastward, in Tilsonburg and Mary's, considerably greater; exceeding by an unknown amount, in th localities, 854 and 700 feet.

Thickness of Corniferous.

As the few observations which we as yet possess of the thickness the Corniferous limestone in this region, do not warrant us in assigning t a thickness of over 200 feet, it is evident that at London and in Enniskil the hard strata which form the upper portion of the Onondaga formati and have at Goderich a thickness of not less than 775 feet, are grea reduced in thickness, since the volume of the two united is only 600 fe To the south-eastward, however, the augmented thickness of theOnonda would appear, from the results of the borings at St. Mary's and Tils burg, to be maintained. The thickness of this formation is, however, kno to be very variable; while at the Niagara river it is reduced to 300 fe and is apparently destitute of salt, it augments to the eastward, in cent New York, where it again attains a volume of from 700 to 1000 fe being equal to that observed at Goderich, and becomes once more sa bearing. The increased thickness of the formation, in these two regio connected with accumulations of salt at its base, would seem to point ancient basins or geographical depressions in the surface of the und lying formation, in which were deposited these thicker portions.

Thickness of Onondaga.

Most of the details here given with regard to the thickness and charac of the rocks of this region are condensed from the observations collect in my Report for 1866, pp. 241-250. They are embodied in a paper me entitled *Notes on the Geology of South-western Ontario*, and publish in the *American Journal of Science* for November, 1868; parts of wh have been reprinted, with some few changes, in the last three pages.

Syracuse salt region.

It is a curious fact that the numerous and productive salt wells Syracuse, New York, although occurring upon the outcrop of the On daga formation, do not penetrate into it, but are sunk in a deposit stratified sand and gravel, which fills up a valley of erosion on the sho of Onondaga Lake. The limits of this valley are nearly four miles fr north to south, by two miles from east to west. The shales belonging the base of the formation crop out to the northward, and are found in t various borings beneath the ancient gravel deposit, which is itself cove by thirty or forty feet of a more recent deposit of loam or sand. The b tom of the basin is very irregular, the shales being met with at depths from 90 to 180 feet in some parts, and at 382 feet in the middle of t valley. According to Mr. Geddes, the greatest depth of this ancient ba

ot less than 414 feet below the surface-level of Onondaga Lake, and 50 below the sea level.—(Trans. N. Y. State Agricultural Society, 59.)

3eds of the ancient gravel are occasionally found converted into a hard crete, the cementing material of which, in some cases at least, is crys- ine laminated gypsum. The wells are bored in this gravel to various ths up to 350 feet; brine is met with at about 100 feet, but the brines the deeper wells are stronger, and less liable to variations in quality 1 the season of the year.

'he report of the superintendent of the Onondaga salt springs, for 1868, tains some interesting details of wells sunk in this region during the ceding year. One of these, at a distance of two or three hundred ds from the wells which supply with brine the Liverpool district, was nd to be outside of the gravel basin, the green shales of the Onondaga nation having been encountered at a depth of 82 feet, beneath which strata, to a depth of 715 feet from the surface, consisted of green, red gray shales, with a few beds of bituminous limestone, and a little sum, green shales forming the base. Fresh water was met with at feet, and salt water first appeared at 164 feet. Analysis of the ne waters, from 291 and 540 feet, are given by Dr. Goessmann. That n the latter depth contained in 100 parts, chlorid of sodium, 4.5478; rid of calcium, 5.8658; chlorid of magnesium, 2.0237; sulphate of e, 0.1070 = 12.5433. The water from the higher level contained rly the same proportions of elements, but was less strong. The water n a well 148 feet deep in the shales, four miles farther west, was very lar in composition to that of which the analysis has just been given, the same is true of two wells sunk in 1867 at Canastota, about twenty s to the eastward of Syracuse. Salt wells.

n one of these, after penetrating through about 300 feet of red and clays, a cemented gravel was met with, followed by loose gravel and l to a depth of not less than 648 feet, where a hard rock was encoun- d, and the boring discontinued. The water from these wells was a ng but bitter brine containing in 100 parts, sulphate of lime, 0.0058; rid of calcium, 4.8200; chlorid of magnesium, 0.9281; chlorid of um, 15.2288, and carbonate of iron 0.0150. For this analysis and cription of the well I am indebted to Dr. C. A. Goessmann. Here, 1, as at Syracuse, the brine occurs in a deep excavation in the Onon- a formation. The shales of this region, as long since pointed out by on, show, in many parts, peculiar hopper-shaped markings, which are gnized as the casts of crystals of chlorid of sodium, and hence it was ectured that the source of the brines was to be found in these strata; ough it was not impossible that they might be derived from more Canastota. Source of brines.

recent deposits of rock salt occupying the remarkable gravel-filled ba which are shown to exist at Syracuse and Canastota. The discovery Ontario, of rock-salt in solid masses interstratified with the base of Onondaga formation, leaves, however, but little doubt of the correct of the views long maintained by the New York geologists, that the so of the brine is to be found in this formation. Borings like those of Gode will probably one day show the existence in the vicinity of Syracus similar beds of rock-salt which now yield to the action of infiltrating wa the brines that accumulate in the gravel beds occupying the reservoirs described. These also receive the bitter waters which are derived f the shales of the same formation, and contaminate the brines of Syrac although they do not mingle to any injurious extent with the water f the borings of Goderich and its vicinity.

Port Austin, Michigan.

In this connection it may be mentioned that brine has been obtaine Port Austin, Huron County, Michigan, on the opposite side of the l and a little north of west from Goderich. The surface rock of this re is a sandstone of the Chemung formation, beneath which, at a depth 1198 feet from the surface, there was extracted a brine of which a speci furnished to Dr. Goessmann marked 88° of the salometer, and gave 100 parts, chlorid of sodium, 17.6161; chlorid of calcium, 3.12 chlorid of magnesium, 1.5675, and sulphate of lime 0.0129 = 22.3239. thicknesses of the different formations across this western region, from N York to Michigan, are well known to be very variable, and it is impossi with our present data, to say at what depth the Onondaga formation sho be found at Port Austin ; but the occurrence there of a brine at 1198 would indicate either a considerable diminution in the volume of the st between the base of the Onondaga and the Chemung, or the existence a saliferous horizon in the Devonian strata, and consequently intermedi between the Onondaga formation and the Michigan salt group, which situated at the base of the Carboniferous limestone in that State. In vicinity of Lake Huron, in Ontario, the Onondaga has a thickness of 1, feet, the Corniferous probably about 200, the Hamilton very nearly 4 while the Portage group is represented, both near Sarnia and in adjoining state of Michigan, by more than 200 feet, making thus 1800 f from the base of the Onondaga to the summit of the Portage formati (Report for 1866, p. 241-250.) The above facts with regard to salt Michigan and New York, are worthy of being put on record, as they m be found to have, in more ways than one, an important bearing on our o salt deposits.

Goessman's researches.

Some are private communications of C. A. Goessmann, D., now professor of chemistry at Amherst, Mass., but for several ye chemist to the Onondaga Salt Company. His published papers on Onondaga brines in the *American Journal of Science* for 1866, [2] XL

1, 368, have also been consulted, and various pamphlets and reports by n will be frequently cited in the course of this Report. I take this occa- n to express my deep sense of the value of his important contributions to e chemistry of salt-making in New York, and of the courtesy with which has aided me in my inquiries into the salt manufacture at Syracuse. e has also visited the Goderich region and submitted the brine to analysis.

ANALYSES OF THE BRINES OF GODERICH AND ITS VICINITY.

In the Report for 1866, a first analysis was given of the brine extracted m the well of the Goderich Company, the first one bored at Goderich, d at that time not yet pumped in a continuous or regular manner. Since t time the well has furnished an uninterrupted supply of salt water, and s yielded, for the greater part of the time, 100 bushels of salt daily. It comes therefore an interesting inquiry whether, during this period of more n two years, the composition of the brine has undergone any change, d to this end we may compare four analyses made from brines taken the dates given below, the analysis II. being by Dr. Goessmann, the ers by myself:—

Goderich Co.'s well.

I. August 19, 1866; cited from Report for 1866, page 269.
II. April 1867; from a Report by Dr. Goessmann.
III. February 1868; brine sent me by the proprietors of the well.
IV. November 5, 1868; brine collected by me at the well.

Analyses.

	I.	II.	III.	IV.
Chlorid of sodium......	259.000	241.433	undet.	236.410
" " calcium....	.432	.216	.182	.190
" " magnesium.	.254	.336	.288	.410
Sulphate of lime......	1.882	5.433	.5679	4.858
	269.568	247.418	....	241.868
Specific gravity.......	1.205	1.195	1.192	1.187
Degrees of the salometer.	100°	95°	94°	92°

The cause of these variations is to be found in the fact that the sources saline matters in these brines are three-fold: 1st. The solution of nearly re rock-salt; 2nd. The solution of beds of gypsum or sulphate of lime, ich lie in the shales above the salt; and 3rd. The intermixture of bitter ters, containing large proportions of chlorids of calcium and magnesium. ch waters occur in the strata both above and below the salt deposit, and come mingled with the fresh waters which flow in to supply the void caused pumping. The composition of these bitter waters is very variable; in ne the chlorid of calcium and in others the chlorid of magnesium predomin- s. The waters of this class are noticed in connection with salt-making

Causes of variation.

in the report just cited, page 271, and analyses are given on pages 27 273 and 276. The analysis of a similar water from Syracuse is given in t present report on page 219. The quantity of bitter salts in the Goderi brines, however, is insignificant when compared with those of most other sa producing regions. It is to be noticed that at the time of the first analys the well was not regularly pumped, and that the brine, though saturated, co tained less gypsum and more chlorid of calcium than it has since yielde while the chlorid of magnesium has somewhat increased in quantity. T density of the brine is subject to some little variation, but is said in t Goderich Company's well rarely to fall below 92°, and after a repose of few hours to rise considerably above it. Of the other wells which have bee sunk at Goderich, four were being pumped at the time of my last visit, November, 1868, and from these I took specimens of brine. It was n considered necessary to analyse these brines from adjacent wells of t same depth, but their specific gravity at 62° F. was determined, and is he given, with the corresponding degree of the salometer:—

Goderich Company's well,	density	1.187	equal	92°	salometer.
Dominion well,	"	1.175	"	87°	"
Huron well,	"	1.176	"	87°	"
Ontario well,	"	1.160	"	81°	"
Victoria well,	"	1.160	"	81°	"

The brines of Clinton and Kincardine shew a strength and purity co parable to those of Goderich. Of the following analyses, V is that of t brine from the Clinton well, collected by me on the 6th November, 186 and VI is that from Kincardine, sent to me by the proprietor a few da later, the well not having been in operation at the time of my visit to t district:—

	V.	VI.
Chlorid of sodium	204.070	241.350
" " calcium	.470	.840
" " magnesium	.184	.230
Sulphate of lime	5.583	3.264
	210.307	245.484
Specific gravity	1.157	1.191
Salometer	80°	94°

MANUFACTURE OF SALT AT GODERICH AND CLINTON.

Of the wells above mentioned, that of the Goderich Company has bee regularly worked since October, 1866, and the manufacture of salt wa commenced at the four others named above, the Dominion, Huron, Ontario and Victoria wells, during the summer months of 1868. In November

, the boring of three others was nearly or quite completed. Two of ;e, called the Prince and Maitland wells, are, like that of the Goderich npany, on the north side of the Maitland River, while a third, the umseh well, is on the south side, near the others mentioned above. number of kettles used, and the daily produce of the wells then in ration was, in November, 1868, stated to be as follows:— Goderich. Salt works.

Goderich Co,	104 kettles.	yielding	100 barrels of salt.
Dominion,	60 "	"	55 "
Huron,	120 "	"	110 "
Ontario,	60 "	"	55 "
Victoria,	60 "	"	55 "
	404 kettles	"	375 barrels.

he Goderich Company and Huron wells have two blocks of kettles , the others but one, the block of kettles consisting of two parallel rows rom twenty-six to thirty cast-iron kettles each. The arrangement is ed from the works of the Onondaga Company, at Syracuse, New York, re the number of kettles in a block varies from fifty to sixty. The city of the kettles used at Goderich varies from 120 to 140 gallons, arger ones being placed towards the front, and exposed to the greater , from which, however, they are partially protected by arches contted under the first nine or ten kettles. At Syracuse, in some of locks, the rear kettles have a capacity of not more than 100 gallons. cost of a block of sixty kettles at Goderich is said to be $1,500, to h is to be added for the construction of the furnace, $1,600, making al of $3,100. Salt boiling.

e fuel hitherto used at Goderich has been chiefly wood, which costs $2.50 the cord. Bituminous coal, which has been tried there to a extent, is shipped from Cleveland, and delivered at Goderich, as I nformed, for $3.80 the ton. The amount of salt to be obtained by se of a cord of wood, at Goderich, was variously estimated by the ent salt-makers. The figures furnished me by Mr. Samuel Platt, ı seem to be the result of careful observations at the Goderich Com-'s works, give a consumption of sixteen cords of hard-wood for one red barrels, of five bushels each, of salt. Of this amount of wood one -half cords are consumed for the engine employed in pumping the , leaving fourteen and a half cords for the evaporation, which gives 34½ bushels to the cord of wood. The estimates at two other wells, me by persons worthy of confidence, corresponded respectively to nd 36 bushels to the cord, and we may therefore, I think, assume ıshels of salt, of 56 pounds each, to be the average result for the of hard-wood employed at Goderich. Fuel; coal and wood.

At Syracuse, where wood is also used to a considerable extent, yield of salt is from 37 to 38 bushels to the cord of wood, and the to coal gives about the same amount, so that in round numbers the produc of a pound of salt there, requires the combustion of a pound of coal (37 56 = 2072 lbs.) The cost of coal delivered to the salt-makers Syracuse was, in 1868, $8.50 American currency. The wood used th by some of the manufacturers is cut from lands in the vicinity. F these figures, which I received at Syracuse from what I consi undoubted authority, it would seem that the salt-makers of Goderich not be gainers by the attempt to substitute imported coal for the woo their own neighborhood, since, while the cord of wood is equal in producing power to a ton of coal, its cost in round numbers, is, at pre prices, only two-thirds as much.

Syracuse and Goderich brines.

The brines of Syracuse mark from 59° to 65° of the salometer, w those of Goderich, as seen above, give from 81° to 90° and even 95°. pure brine of 60° contains 15.6 per cent. of salt, and 38.9 gallons of it required to yield a bushel of salt; while a brine of 90° holds 23.4 cent., and yields a bushel of salt for 24.5 gallons. Hence it appears t in round numbers, the Goderich brines contain about one-half more than those of Syracuse, or are fifty per cent. richer. So that, as remar by Dr. Goessmann, we should expect fifty-two bushels as the yield at G rich for the cord of wood, being an increase of nearly 50 per cent. that now obtained.

This great discrepancy between what might be expected, and the re actually obtained at Goderich, is easily explained, and is found in the that the system of evaporation pursued at Syracuse, and adopte Goderich, is one not suited to the strong brines of the latter region. this point Dr. Goessmann remarks that the only difficulty with which salt-makers of Goderich have now to contend "is the rapid incrusta of the kettles, a trouble due to the strong concentration of their brin connection with their peculiar system of manufacture." Under t circumstances, the salt separates in considerable amount in very grains, and a hard incrustation forms on the bottom and sides of the ket which soon becomes several inches in thickness. This not only caus considerable waste of salt, since these crusts are not fit for market, what is of much greater importance, prevents the economical applic of the fuel; besides which, the necessity of a frequent removal of the c of salt generally keeps one of each row of kettles out of service. crust may be removed either by mechanical means, or by dissolving it with fresh water, a process which involves the loss of time, fuel and With weaker brines, on the contrary, like those of Syracuse, the supplies of brine added to the emptied kettles suffice to dissolve any

Incrusted boilers.

; crust, and the difficulties which cause such a serious loss at Goderich : not felt.

Dr. Goessmann proceeds, in describing the manufacture at Goderich :— Goessmann's opinion. "he salt is, after separation from the pickle, (mother-liquor) as might ve been expected from a brine like that of Goderich, of a superior or, of a hard fine grain, resembling the best brands of home and foreign nufacture, and this success is attained without any but the ordinary e required for the manufacture of common fine salt. It will be noticed t the sole objection which may be raised against the Goderich brine, is rely incidental, for the brine is too strong to be worked to its full rantage by the system of manufacture at present pursued. Evaporation by re moderate heat, for instance, on the European plan of large pans, or poration by solar heat in wooden vats, on the Onondaga plan, would, no ıbt, prove more successful. Each of these methods would produce, with ; trouble, not only a very good marketable article of its kind, but secure at is most important, the full percentage of salt, which might be ected, comparing its concentration with the brines of Onondaga, to a difference of 50 per cent."

The above extracts are from a printed Report by Dr. Goessmann, ed January, 1868, on the salt resources of Goderich. Since that time system of evaporation in pans has been tried at Clinton, and the results y justify the recommendation by Dr. Goessmann. The Stapleton salt- Evaporation in pans. k here erected by Mr. Ransford, has two pans, each twenty-one feet e by forty feet long, and fifteen inches deep. Under the front pan three od fires are kept up ; the brine in this is maintained in rapid ebullition, Clinton. le the waste heat passes under the second pan, in which a slower eva- ation goes on, producing a coarse flaky salt. The daily production of se two pans was, I was informed, equal to fifty barrels of fine salt from front pan and twenty barrels of coarser salt from the rear one, equal seventy barrels, and the consumption of wood for this production was en cords, being at the rate of fifty bushels of salt for the cord of wood. hough the brine was said to mark generally 85°, the specimen taken by , whose analysis is given on page 221, was not above 80° ; the result thus ws most satisfactorily the greater economy of fuel to be attained by the of pans, and the utilization of the waste heat, as practised at Clinton. e crust which forms on the first pan is removed once a week, and is nd in that interval of time to be from one and a quarter to one and a f inches in thickness. But very little crust is deposited in the rear pan, ept at the end nearest the fire. In Cheshire, in England, where nes as concentrated as those of Goderich are evaporated, pans similar in nensions to those at Clinton are made use of ; while single pans, having readth of twenty by a length of forty feet, and a depth of two feet, are

also employed, in which the evaporation is carried at temperatures as as 150° Fahrenheit, for the production of coarse salt.

Platt's system. Mr. Samuel Platt, under whose superintendence the first salt was r at the Goderich Company's well, has patented an evaporating pan, to w the heat is applied by the means of steam heated to a pressure of tl pounds. In this way it is expected to effect an important saving of and obtain other advantages. I have not yet learned the result of ex ments in progress for the purpose of testing the merits of this sys Several other proposed improvements in evaporators have recently made the subject of patents in Canada.

Purity of the brines. Attention was called, in the Report for 1866, to the great purity o Goderich brines, of which Dr. Goessmann subsequently writes, in his re already cited: " The present brine of Goderich is not only one of the concentrated known, but also one of the purest, if not the purest, at pre turned to practical use for the manufacture of salt;" and he proceed

Earthy chlorids. remark that the proportion of obnoxious deliquescent chlorids (of calc and magnesium) is from one-fourth to one-fifth of that found in brines of Syracuse. It will be seen by referring to the table of analy given on page 221, that the proportion has not increased after more than years pumping of the well first sunk; the only change being that amount of gypsum has augmented. The earthy chlorids, just mentio being much more soluble than the salt, do not separate, but remain bel in the mother liquor, which should, from time to time, be emptied from evaporating vessels. From a neglect of this it would otherwise hap that the salt would, after a time, be rendered impure from the adhe

Mother liquors. mother-liquors, and be reduced to the condition of salt manufactured f inferior brines like those of Saginaw; the impurity of which consists in th same earthy chlorids, which it becomes necessary to remove by a spe process. The precaution of throwing out the mother-liquors from tim time, has not been attended to at Goderich; and when it is found necess to empty a kettle for the purpose of removing the crust, it has been practice to transfer the brine into an adjoining kettle. The effect of is shown by the following comparative results for 100 parts of brine; being the recent brine, marking 94°, whose analysis is given at III. page 221, and B, a saturated brine, marking 100°, taken from one of boiling kettles at the same time:—

	A.	B.
Chlorid of calcium	·182	·688
" " magnesium	·283	1·185
Sulphate of lime	5·679	4·908

The diminution in the amount of sulphate of lime is due to the fact t both heat and the presence of earthy chlorids diminish its solubili

hese latter salts are present in a four-fold proportion in the evaporated ·ine, showing clearly the accumulation of these which takes place when ˌe common salt is removed, and the necessity of throwing out the old ˌuors from time to time.

In the brines of Saginaw, the chlorid of magnesium, which is more obnox-ıs than the calcium salt, is got rid of by the addition of a small portion of ıick-lime, as described in the Report of 1866, page 265. On page 267 that report will be found analyses of brines from other regions, that of ·racuse included, which, as we have seen, contains from three to four ıes as much of these bitter earthy chlorids as our own brines. These are composed by an ingenious process, which consists in washing the pre-ously drained salt in a pure saturated brine, to which has been previously ded a sufficient proportion of carbonate of soda to decompose the earthy ıorids present in the salt, the proportion being determined by the results analysis. The salt purified by this operation is drained, and partially ˌed in bins, after which the drying is completed in hot-air chambers, or revolving cylinders heated to 250°—300° F., and the salt finally ·eened and ground. This process yields the so-called "Factory-filled lt" of Syracuse, greatly estimated for dairy use, of which about 700,000 shels are manufactured yearly.

Purifying salt.

Factory-filled salt.

ON THE MANUFACTURE OF SOLAR SALT.

We have already referred to the advantages offered by Goderich for manufacture of solar salt, and now propose to give a brief account of system pursued for making it at Syracuse, New York, based upon blished reports, and upon my own observations in 1868. The condi-ns in which the brine is met with in a gravel-filled basin of small extent the shores of Onondaga lake, near to Syracuse, have already been scribed. The salt-producing area, known as the Salt Springs reserva-ı, is divided into four manufacturing districts, known as the 1st, or racuse, the 2nd, or Salina, the 3rd, or Liverpool, and the 4th, or Geddes trict. The wells in the Liverpool district became valueless and were ındoned in 1866, and the brine now required for the works at Liverpool aised from the wells in the Salina district, and conveyed by a line of ·ed logs of nine inches calibre, to a reservoir seventy-five feet long, y-three feet wide, and eight feet deep. The large reciprocating pumps herto used are now being replaced by small rotary brass pumps, one of ich, costing $300 American currency, is said to be sufficient for the st abundant well.

Syracuse salt works.

The various salt-makers in these four districts, were in 1860, united into incorporated company, known as the Salt Company of Onondaga. By

Onondaga Salt Co.

this union of their interests under one head they have been enablec secure great advantages. Among these have been the appointing agents in the principal markets of the country, the establishment c general direction ensuring uniformity in the quality of the salt and mode of preparing it for market, and finally the employing of a scient chemist to direct the works, and, by careful studies, to suggest impro methods of manufacture.

Annual production. These works pay to the state a tax of one cent per bushel, beside rental, which is, however, insignificant, since it appears that the whole s paid by the Company to the state in 1867, for rents and penalties, only $102 ; the duty amounting for the same time to $75,956.06, being 7,595,565 bushels of fifty-six pounds each, the amount inspected in 18 Of this amount, 2,271,892 bushels were made by solar evaporation 5,323,673 bushels by boiling. Of the solar salt, 308,266 bushels w ground, and of the fine or boiled salt, 188,866 ; of which 41,929 bush prepared in the Geddes district, are described as table-salt.

I am not able to give the entire number of blocks of kettles in the est lishments of the Company ; but it is stated in their report for 1867, that average daily produce of salt for each block during the year was equa nearly 261 bushels, while the average from the seven blocks of kettles Goderich, from the figures given on page 223, was 268 bushels.

The cost of making solar salt in the Onondaga region is estimated to a little less than that of boiled salt.

Solar-salt making. The process of making solar salt at Syracuse is divided into three stag First, the settling of the brine, as it is called ; second, its concentration what is called pickle-making ; and third, the making of salt from the picl The brine after being raised, is stored in reservoirs, from which it is

Settling-rooms. through bored logs to the deep-rooms or settling-rooms, as they are term where it is exposed to the air in large tanks, which are deeper than th used in the subsequent stages. There the brine absorbs a portion oxygen from the air, by which means the carbonate of protox of iron, which is dissolved in the recent brine, is converted into insolu peroxyd of iron. This separates in a hydrated form, as an insolu yellowish mud, which accumulates in the bottom of the tanks, and the br becomes clear and colorless. This first stage is not required for Goderich brines, which are free from any trace of iron.

The process of evaporation, of course, begins in the settling room, bu

Lime-rooms. continued in what are variously called lime-rooms, gypsum-rooms, or plast rooms, from the fact that the sulphate of lime or gypsum, (which is the sa substance as uncalcined plaster of Paris) is here deposited in a hydrat state, and in the form of crystals, which in time nearly cover the bottoms

Gypsum. the vats. As the brine approaches saturation, flakes of gypsum are se

ating on the surface of the liquid, and at length the appearance of crystals salt shows that the second stage of the process is accomplished, and that e saturated brine, known as salt-pickle, is ready for the third stage. This then at once removed, and is ready for the salt-rooms, in which the position of the salt goes on.

By salt-rooms are meant areas occupied by the evaporating vats or vers, as they are called, which are provided with moveable roofs, that n be drawn over the covers in rainy weather, but withdrawn at other mes, so as to expose the brine to the action of the wind and sun. The vers are rectangular in shape, and all of the same size, being sixteen by ghteen feet, and six inches deep. They are raised on wooden supports o or three feet from the ground, and are arranged in sets or strings, each om four to six inches above the other, so that the liquid can be made to w from the higher to the lower by opening small gates. The whole numr in use at Syracuse in 1867 was 41,718; of these, in round numbers, o-fifths belong to the settling and gypsum-rooms, while three-fifths, or out 25,000, are salt-covers. The average yield for each cover at the lt Company's works was, in 1867, 54⅝ bushels; while for the salt-covers, hich are fed with saturated brine, it would, if we take their number to be ,000, equal more than 90 bushels to the cover, for the season. With e purer and more concentrated brines of Goderich the settling tanks are necessary, and the time required in the gypsum-rooms to bring the brine the condition of saturated pickle would be very much abridged, so that a uch less proportion of the covers would be required for the gypsum-rooms, d the average production of salt to the whole number of covers, very eatly increased.

Salt-rooms.

Salt-covers.

One of the conditions required for the production of a good largeained solar salt, which is most esteemed in the markets, is that the botm of the covers in the salt-rooms should be as smooth as possible; rough rfaces favoring the deposition of numerous small crystals. It is also necesry to have the salt-covers supplied with a sufficient supply of good pickle, that the salt already deposited may always be covered. An exposure the salt uncovered to the air favors the formation of new small crystals, d the addition of an unfinished or not sufficiently concentrated pickle oduces the same effect, inasmuch as it brings an excess of sulphate of ne into the salt-room; and the increased separation of gypsum will also use the production of a larger proportion of fine grains of salt. It is so of great importance that the waste pickle, from which the greater rt of its salt has crystallized, should be removed from time to time, as its esence not only impairs the quality, but diminishes the quantity of the lt deposited.

Conditions for working.

A correct understanding of the chemical relations of the various con-

Chemistry of brines.

stituents of brines is so important to the manufacturer of salt that i well to enter into some details on the subject, and to embody the resul a very careful and valuable series of experiments carried on by Goessmann at Syracuse, and published by him in a report to the Onond Company in 1864. In the Report of the Geological Survey for 1853– pages 404–419, I have described in detail the manufacture of salt by evaporation of sea-water, and the chemical reactions which come into p in the process.* The composition of sea-water differs in some import particulars from that of brines like those of Syracuse and Goderich, especially in the presence of a large amount of sulphates, so that evaporated brine or salt-pickle from sea-water contains no chlorid of cium and only a trace of gypsum, but besides a large proportion of chlo of magnesium, a considerable amount of sulphate of magnesia.

Their composition.

The compounds found in native brines, like those of Goderich and Sy cuse, are as follows: 1st, chlorid of sodium or common salt; 2nd, chlo of calcium; 3rd, chlorid of magnesium; and 4th, sulphate of calcium sulphate of lime. In addition to these, small portions of carbonate of iron often present; this substance is separated at an early stage of the proce as already explained, in the form of hydrated peroxyd of iron, and unl carefully removed in the settling-tanks gives a reddish tint to the sa This objectionable impurity is, however, entirely absent from the brines Goderich and its vicinity. In addition to the substances already m tioned, the brines contain small portions of chlorid of potassium and bromid of magnesium. These, however, have no perceptible influence the manufacture of salt. The chlorids of calcium and magnesium, bei compounds of what are sometimes called the earthy metals, are frequen spoken of as earthy chlorids, a term which, for convenience, will som times be made use of in discussing the relations of the various elements brine to water and to each other.

Earthy chlorids.

Solubility of salt.

A saturated brine prepared with pure water and pure salt (chlorid sodium) has a specific gravity about 1.205 at 60° Fahrenheit, (Liebi and contains 26.423 per cent. of salt. The presence of earthy chlori however, diminishes the solubility of salt in water, so that a saturated bri containing these chlorids is less rich in salt than if it were pure. Anoth point to be considered in this connection, is that as these chlorids are mu more soluble in water than the salt, the latter crystallizes out first, leavi them behind in the pickle, where they accumulate; the salt which separat retaining only so much of the earthy chlorids as is present in the pick which moistens it. At length, after the separation of the greater part the salt, either by boiling or by solar evaporation, the proportion of the

* See also the American Journal of Science for 1858, vol xxv. page 361.

lorids becomes so great that they predominate in the pickle or mother-quor, which becomes what is called bittern by the makers of salt from a-water. It has a sharp and bitter taste from the presence of the lorids of calcium and magnesium, and as these compounds have a great traction for water, and even absorb it from moist air, when in concentrated lutions, it follows that the pickle from which the greater part of the salt s been separated no longer loses water by exposure to the air at ordi-ry temperatures, and although very dense, and marking a high degree the salometer, holds but a small proportion of salt. Mother-liquor.

The sulphate of lime presents curious relations both to water and to the her compounds present in natural brines. 100.00 parts of pure water, ordinary temperatures, dissolve about .25 parts of the sulphate of ne, but it is somewhat less soluble in water at the boiling point, and at gher temperatures becomes almost insoluble; a property which causes it be deposited in high-pressure boilers in which sea-water and other aters holding this sulphate in solution, are exposed to temperatures much ove 212° F. Sulphate of lime is much more soluble in a strong lution of salt than in pure water, while on the other hand the earthy lorids diminish its solubility. Thus 100.00 parts of pure saturated brine e capable of holding in solution from .50 to .60 parts of sulphate of lime ile in the bittern or pickle in which there has accumulated a large ount of earthy chlorids, the sulphate becomes nearly insoluble. Its lubility in brine, as in pure water, is also diminished by heat, so that a ine brought to saturation by boiling, deposits more of its sulphate of lime an if concentrated by evaporation at the ordinary temperature. These ints are exemplified by the following series of analyses made by Dr. oessmann with the especial object of throwing light upon the manufac-re of solar salt at Syracuse. Sulphate of lime. Goessmann's experiments.

I. Brine from one of the wells at Syracuse, having a specific gravity of 1225, which corresponds to 65° of the salometer at 70° F.

II. Pickle or saturated brine obtained by concentrating I by solar heat til it was ready to deposit salt. It then had a specific gravity of 1.2062, ual to 100° of the salometer at 70° F.

II A. An artificial brine, almost identical with the last, and prepared certain experiments to be mentioned farther on.

III. Pickle "from the *first cover* of a string of salt-vats numbering m thirty to thirty-four covers. The latter were partitioned into two b-divisions. The one towards the head of the string was from five to inches higher than the one towards its termination."

IV. Pickle "from the *last cover* of the same string," the whole having en filled with new pickle for the season's work. The liquid flows from I down to IV, so that the latter represents a pickle which has parted th a considerable portion of its salt.

V. Pickle from the last cover or string of a similar series, at the midd of the summer season, when evaporation had proceeded so far that t pickle was low and the salt partly bare.

A comparison of the results given under II, III, IV, and V, will sh that in these pickles, the proportion of sulphate of lime diminishes as tl of the earthy chlorids increases.

	I.	II.	II A.
Sulphate of lime	0.5772	0.4110	0.4090
Chlorid of calcium	0.1533	0.2487	0.2687
Chlorid of magnesium	0.1444	0.2343	0.2578
Chlorid of potassium	0.0119	0.0194	0.0194
Bromid of magnesium	0.0024	0.0039	.....
Carbonate of iron	0.0044	.....	.....
Chlorid of sodium	15.5317	25.7339	25.6906
Water	83.5747	73.3488	73.3545
	100.0000	100.0000	100.0000

	III.	IV.	V.
Sulphate of lime	0.3188	0.1146	0.0264
Chlorid of calcium	0.4223	2.6959	10.4690
Chlorid of magnesium	0.6005	2.7513	10.5020
Chlorid of potassium	0.0194	0.8177	3.3769
Bromid of magnesium	0.0331	0.1160	0.4485
Chlorid of sodium	25.0462	20.1096	8.7441
Water	.....	.....	.....
	100.0000	100.0000	100.0000

In this connection Dr. Goessmann gives the following analyses, in whi VI shows the proportion which the sulphate of lime and the earthy chlori bear to the salt in the fresh pickle, II; and VII the average composition the solar salt made from this pickle at Syracuse. These results show tl only about one-eighth of the earthy chlorids present in the fresh pickle a retained by the salt, the remainder accumulating in the mother-liqu except a small portion, which is supposed to pass through the pores of t wood.

	VI.	VII.
Sulphate of lime	1.5400	1.3378
Chlorid of calcium	0.9335	0.0932
Chlorid of magnesium	0.8817	0.1200
Chlorid of sodium	96.6448	98.4490
	100.0000	100.0000

The composition of the old and half-exhausted pickles is shown in t analysis IV, and at a still later stage in V. The evils resulting fr this accumulation of chlorids are many: first, the salt removed from the

Effects of earthy chlorids.

mpregnated with a very impure pickle, which not only adheres to the rstals, but fills small cavities in them; the presence of these earthy lorids being unfavorable to the production of solid crystals free from rities. These adhering solutions of earthy chlorids never dry completely ordinary temperatures, and keep the salt constantly moist, and very sily affected by damp weather. Again, these impurities affect the quan- y as well as the quality of the salt produced, by retarding the process evaporation. Under any circumstances the force of affinity causes such ine solutions as these to evaporate less rapidly than pure water, at ordi- ry temperatures. Thus it was found by Dr. Goessmann, on exposing equal lumes to evaporation under the same conditions, that while pure water t 60 per cent. of its volume, a recent brine, marking 65° of the salometer, nalysis I) lost but 45 per cent., a fresh pickle 43.66, and an old partly hausted pickle only 30.05 per cent. of its volume. Were the last to aporate as rapidly as fresh pickle, it would yield a less quantity of salt, ce, as appears from the analysis already given, it contains less lt for the same volume; but in fact, its evaporation is much retarded by affinity of the earthy chlorids for water. This becomes so manifest at, after a certain stage of concentration, evaporation ceases altogether ordinary temperatures. It is well known to chemists that these chlorids, evaporated to dryness by artificial heat, will, on exposure at ordinary mperatures, absorb moisture from the air, and redissolve, or deli- iesce, as it is termed. A similar process takes place with the concen- ated bitterns, which at the temperature of the air lose water in dry ather, and absorb it again in moist weather. This process, and the effect the purity of the pickle upon the quantity of salt produced, is shewn by e following experiments of Dr. Goessmann:—An artificial pickle, closely sembling the fresh pickle II, and having the composition represented der II A, having been prepared, five glass basins were arranged, and aced in a position exposed to air and light, but sheltered from rain. Of ese vessels, 1 was filled with the pickle II A; 2, with equal parts of A and III; 3, with equal parts of II A and IV; and 4, with equal parts II A and V; while 5 was supplied only with the impure pickle V. It as found that during the whole season the 600 volumes of this last, taken r the experiment, were never reduced below 320, a bulk which was sub- quently augmented to 340 volumes when the damp weather of autumn me on. After an exposure during the whole salt-making season, the lt from each basin was collected and carefully weighed, with the follow- g results, the produce of the fresh pickle being taken at 100:—

Rates of evaporation.

Goessmann's experiments.

1.	gave of salt........................	100·00	parts.
2.	" " "	99·72	"
3.	" " "	95·35	"
4.	" " "	81·3	"
5.	" " "	15·60	"

From the sparing solubility of salt in a bittern like V, it results that fresh pickle be mixed with it, the mixture can no longer hold the whole the salt in solution, but deposits a considerable portion of it in fine grain All of these considerations shew that the accumulation of the impu liquors in the salt-covers is to be carefully avoided, and that they shou be thrown away before they reach such a stage of concentration and imp rity as to retard the efficient working of the process and reduce the yie of salt. Such a result is shewn in the experiments 3 and 4, where th falling off in the production is seen to be five and nineteen per centur

Dense pickles. These impure pickles have a specific gravity considerably greater than th of pure saturated brines. Thus, according to Dr. Goessmann, the pickl V, which contains less than nine per cent. of salt, marks 32° on Beaumé scale, which corresponds to a specific gravity of about 1.278, and woul equal 123° of the ordinary salometer, were the scale of this instrument be extended; while a pure saturated brine, of 100° of the salometer, corre ponds very nearly to 25° of Beaumé's areometer. Dr. Goessmann recom mends this latter instrument to be used for testing the old liquors, an states that a pickle marking 30° Beaumé (equal to a specific gravity 1.256) is to be rejected, as no longer fit for the purpose of makin solar salt.

It will be seen from the analyses already given that the small amount of chlorid of potassium and bromid of magnesium which these brines contain accumulate in the old pickle, and might, perhaps, in some cases be turne to account as sources of potash and of bromine. Though this is no

Bromine. attempted at Syracuse, bromine is manufactured from the bitterns of salt springs in western Pennsylvania and in Germany, and potash salts are extracted from the bittern of sea-water on the shores of the Mediterran ean. The brines of Goderich are fortunately so pure that these foreign elements are present in too small amount to be of significance, althoug traces of both potash and bromine are found in them.

As we have seen that the earthy chlorids are the most objectionable

Brines compared. impurities in natural brines, it will be well to compare our own with those of Syracuse and of Saginaw. The following table shews the proportion of the two chlorids united, and also that of the sulphate of lime, calculated for 100.00 (one hundred parts) of the solid matters of the different brines; the difference between the sum of these and 100.00, being in each case pure salt.

Goderich.

			Earthy chlorids.	*Sulphate of lime.*
1.	Goderich Co's. well,	Aug. 1866	·26	·69
2.	" "	Apr. 1867	·22	2·19
3.	" "	Nov. 1868	25	2·00
4.	Clinton " " "		·31	2·65
5.	Kincardine " " "		·44	1·33

6. Syracuse brine, analysis I, page 232,.......... .	1·42	3.51	Syracuse.
7. " saturated salt pickle,................	1·81	1.54	
8. Saginaw brine (analysis by Douglas),..........	16·63	.53	Saginaw
9. " " (" Dubois),...............	17·42	2.20	
10. " " (" Chilton),.............	22·89	.45	
11. " " (" Webb),...............	8·04	undetermined.	

'he amount of sulphate of lime in the Goderich brine in August, 1866, re the well was pumped, was very small, though it has since increased. smaller proportion contained in the Saginaw brines is due to the large unt of earthy chlorids present, which, as we have said, diminish the bility of sulphate of lime. The proportion of earthy chlorids in the erich brines is seen to be but a small fraction of that contained in those yracuse ; yet in the manufacture of solar salt these chlorids will slowly ımulate, and so require, though to a less degree, the same precautions t Syracuse for getting rid of them from time to time. The following mmendations for the improvement of the solar salt at that place, copied ı the Report of Dr. Goessmann already noticed, which was published 864, are therefore worthy of notice. Alluding to the different stages he process, as described on page 228, which are carried on in three rate systems of vats, known as settling-rooms or deep-rooms, gypsum-me-rooms and salt-rooms, he observes :—

The successful working of these rooms, as a general rule, is best aided uilding them in distinct systems, corresponding with the number of esses intended ; the succeeding set of rooms always from four to six es lower than the preceding ones, and every system with a perfectly bottom, but a distinctly slanting position towards their termination. ı a construction not only favors a desirable independent management ch system of rooms, but admits of a more successful drawing-off of brine ickle. * * * * * The degree in which oottom of every system of vats has to incline, is best regulated by the ective lengths of the strings ; the longer the string of vats the less may ıe rate of inclination. The latter ought to be such as to enable the :men to draw from every one of these divisions, whenever required, that on of the saline solution which has reached the desired point for which ıs retained there. The flow itself, on the other hand, ought to be iently slow to prevent the stirring up, and thus the carrying along of nentary matter to the succeeding division. The latter purpose can be ı aided by a proper distribution of gates for discharging the brine from ıpper to the lower section. Several small gates properly located are ys preferable to one large one ; the additional trouble caused by being oelled to open at every new charge or discharge, several gates instead e, is more than compensated by the decided advantage gained in being led to draw or run off the old pickle uniformly, and thus more effectu- Plan of solar salt works.

ally, towards the termination of the lower rooms. The changes to which
brine is subjected while still in the first two systems of vats—the settl
and the gypsum-rooms—manifest themselves, as we have observed, unifor
ly throughout the whole mass ; and the vats being always filled with a sal
solution of the same or similar original composition, and terminating
each time with a certain uniform state of the solution, in the form o
saturated pickle, do not exactly require separate divisions within th
systems of vats. Nothing remains to be said here in regard to their constr
tion, but that they ought to present a sufficient area of surface for evapo
tion, to enable the manufacturer to feed his salt-rooms whenever it may
required; this being requisite in order to produce a superior article
salt. It may be a very difficult question to ascertain the exact relat
proportion between the surfaces of evaporation in the settling and gyps
rooms on the one hand, and the salt-rooms on the other ; yet to find so
thing near to it is one of the most important questions. A satisfact
decision of that question can only be obtained by adopting a method
working the salt-rooms to the best advantage, a method which tends
protect free evaporation in the salt-rooms from retarding influences—in
ences which are undeniable, yet uncertain in force."

In relation to the foregoing extract, it is to be observed that the prep
tory stage, which requires two sets of rooms at Syracuse, on account of i
in the brine, may, in the absence of this impurity, be effected in a sin
set of rooms, in which the brine shall be brought to the point of saturat
and a portion of gypsum deposited. The stronger the brine also the sma
Gypsum-rooms. need be the area of the gypsum-rooms as compared with the salt-rooms
that the comparative area of the former at Goderich may be very m
reduced, as noticed on page 229. The influences alluded to as retard
free evaporation in the salt-rooms are those of the earthy chlorids, wh
as already shown in page 231, have—when in considerable quantities
powerful effect in this way. Hence, the necessity of getting rid of the
from time to time, by drawing off and rejecting the old pickle before
becomes so impure as to become prejudicial. The means of determin
this point has already been shown on page 234.

As already remarked above, the settling and gypsum-rooms, in which
evaporation is carried only to the point of saturation, do not require sub
visions in their systems of vats or covers ; but for the salt-rooms this is v
desirable, and Dr. Goessmann recommends the following arrangement
Salt-rooms. "The vats are to be built in sub-divisions, with a perfectly even bott
but slightly inclined towards the termination of the string. The first s
division, next to the gypsum-rooms, ought to have the largest numbe
covers, the one following a less number, and the third, if the last, only
cover to every ten or twelve covers preceding in the whole string;

tance the first division may have twenty covers, the second ten, and the rd only three covers. These various divisions ought to be connected th each other by two or, better, three small gates, and the gates between e second and third divisions should be larger than those between the psum-rooms and the salt-rooms. These sub-divisions facilitate a proper ision and economy of the salt pickle."

The vats or covers used at Syracuse have, as already mentioned, a uni- Salt-covers, Syracuse. m size of sixteen by eighteen feet, and while settling-vats are generally eper, those of the gypsum and salt-rooms have a depth of six inches, four hes of which is filled with brine or pickle. This, in the salt-covers, is placed, as it evaporates, by fresh supplies of pickle, a process which is peated as often as the salt itself appears above the level of the pickle, l continued until a sufficient amount of salt has been formed for removal. e gathering of the solar salt usually takes place twice or three times ring a season. The natural consequence of this system of working is t in proportion as salt is obtained from the pickle the soluble chlorids umulate in the remaining portion. This accumulation would sooner or er be felt throughout the whole string of vats used for salt-making, par ularly if they were built on one level, and supplied with new pickle with certain precautions. Such conditions could not but interfere most iously with the quality and quantity of the salt. Hence, as Dr. essmann emphatically says, the whole system of constructing and supply- the salt-vats during the season should be arranged so as keep the v pickle as much as possible separate from that which is old and tially exhausted.

It is with this object in view that he recommends the arrangement of a Mode of working. ing of salt-covers in three successive sub-divisions, numbering, respect- ly, twenty, ten and three. With such a system "the supply of new kle ought to be managed with the following precautions: First, draw as ch of the remaining old pickle as possible from the second into the third ision, then from the first into the second, and, finally, open the gates ween the gypsum-room and the first salt-room, which is thus supplied h fresh pickle. Aim always at the most successful separation of the naining old pickle before supplying the new. The last or lowest cover l thus, in the course of the season, receive almost all the inferior old kle left from the previous charges of the string. The pickle thus accu- lating there will be more or less highly charged with the chlorids of cal- m and magnesium, and a few weeks trial in the next season will soon icate the point where salt-making profitably ceases." As already narked, this impure or worthless pickle is much denser than saturated ne, and its value diminishes with the increased specific gravity, so that

Dr. Goessmann informs us that a brine marking 30° of Baume's areome
is worthless for salt-making purposes.

The site selected for solar salt-works should be on well-drained land, f
from stagnant waters; the vats should never rest upon the earth, a
should turn their open front towards the prevailing currents of air.

Gypsum.

As regards the sulphate of lime, the only foreign material present in a
notable quantity in the brines of the Goderich region, it is to be remark
that it separates with the salt, during the process of solar evaporation
the hydrated form, as small needle-shaped crystals of gypsum, which
up, more or less, the cavities in imperfectly developed crystals of s
adhere to the outside of these, or are mixed, in a loose state, with
bulk of the salt. This latter condition "enables the careful manufactu
to separate a considerable portion of the gypsum by subjecting the sal
a careful washing before harvesting it. An accumulation of a cert
excess of sulphate of lime within the salt-vats, towards the close of the s
son, is almost unavoidable, and it is, for this important reason, v
advisable to return the small-sized crystals of solar salt—for instance,
scrapings of the salt-vats—at the end of the salt-making season, to the g
sum-rooms. This precaution will not only secure an additional return
a superior quality of salt, afterwards, but will leave the excess of sulph
of lime where it properly belongs;" the yet unsaturated brine of
gypsum-room dissolving the salt, but leaving the gypsum behind. "
start the solar salt-making anew from time to time—for instance, ev
spring and fall before closing up the works,—is, on account of ma
advantages, very advisable."

The average amount of sulphate of lime in the solar salt of Syracuse
calculated from the analysis of a good recently prepared pickle, need ne
exceed 1·5 per cent., which amount is considerably less than some of
best and most valued foreign coarse salts contain. The smaller quantity
sulphate of lime actually observed in the solar salt from the first gather
of the season, as well as in the coarser grained portion of the second cr
(from 1·315 to 1·316 per cent.) and the more or less increased prop
tion of it in the finer portion of the various crops, particularly in the
crop of the season, confirm the above statements. Its uniform distribu
throughout the whole of every crop, remains, therefore, the sole object
the manufacturer. Sulphate of lime is generally not considered as in
fering with the effects expected from good solar salt, yet being a mat
foreign to salt, and apparently not directly promoting its specific action
reduction of its proportion in salt should be sought, if for no other reas
for that of improving the appearance of the product. The means
effecting this has already been pointed out in the preceding paragra
The proportion of sulphate of lime to 100 parts of the solid matters of

derich brine is shown by the table on pages 234-35 to be considerably less Goderich and Syracuse brines.
n in the more dilute brines of Syracuse; but the former, during concention to the condition of a pickle such as is required for solar salt, deposits onsiderable portion of the sulphate, so that in the pickle it amounts only 1·54 per cent.; while the Goderich brine, brought to the same condition, ds, on account of its greater purity from the noxious earthy chlorids, an ount of sulphate equal to about 2·0 per cent., or nearly as much as a pure urated solution of salt. From this it will be seen that, while free, to a narkable extent, from the chlorids of calcium and magnesium, whose sence is so prejudicial, the Goderich brines contain of the sulphate of e a somewhat larger proportion than the Onondaga salt. This compound,as eady remarked, is however no way injurious to the quality of the salt; fact, the best Ashton and Turk's Island salt contain rather more sulphate ime than that of Syracuse. It is, as already remarked, the earthy chlorids ich not only injure the grain of the salt, render it liable to get moist in lamp atmosphere, but prove injurious to the flavor of butter, to which y impart a bitter taste. The presence of these in the ordinary salt of racuse having been recognized as impairing its value for the uses of the ry, the treatment of the boiled, and in some cases of the solar salt by a all portion of carbonate soda, as described on page 227, has been resorted producing what is known by the trade-mark of *factory-filled salt,* and, Factory-filled salt.
ng entirely free from the earthy chlorids, is peculiarly fit for the salting butter. It is said that while for any other purposes than for the preserion of butter the presence of small quantities of earthy chlorids is of le or no importance, a very small proportion of them suffices to impair the icate flavor of butter. As our brines contain on an average only oneh or one-sixth as much of these objectionable compounds as those of racuse, it follows that with the same care in making the salt, either by ling or by solar evaporation, a salt would be obtained a holding much less portion of these chlorids than the ordinary salt of Syracuse, and rcely requiring the subsequent chemical process which is there applied their removal.

ADVANTAGES OF THE GODERICH REGION FOR SALT-MAKING.

The finding of salt at Goderich attracted, early in 1867, the attention the Onondaga Company, and Dr. Goessmann, who was sent to examine l report upon the new discovery, visited the region for that purpose in ne, and again in December 1867; his object being to verify the truth the statement made in my Report, published in the spring of 1867, that brine of Goderich was the strongest and the purest known, and also to ermine what were the facilities offered by that region for the manuface of salt. In his Report thereon, addressed to the Onondaga Company,

and dated January 1868, Dr. Goessmann thus sums up the result of examination as to these two points:—

"The present brine of Goderich is not only one of the most concentra known, but also one of the purest, if not the purest, at present turned to manufacture of salt." After referring to the discovery of salt at Clinton, Goessmann proceeds: "Goderich possesses, in a high degree, all necess additional resources and facilities for the manufacture of salt and its tr portation to all the important commercial points in the western lakes, is, therefore, the most formidable competitor which the salt-works of state of New York have ever yet had to contend with." In confir tion of the statements made by me in preceding pages, I make the foll ing citations from the Report in question, premising that they carry greatest weight, from the known scientific accuracy of Dr. Goessmann, from the fact that he has, as chemist to the Onondaga Company, devo himself for years to the study of the salt-manufacture:—

It has been shown by the analyses on page 221 that on pumping Goderich Company's well the density of the brine fell from 100° to 9 while the amount of sulphate of lime increased. These changes w already apparent when, in April, 1867, Dr. Goessmann received sam of the brine and of the boiled salt for examination. His analysis of former has already been given on page 221, II. He proceeds to rema "The two samples of brine tested by Dr. Hunt and myself differ strength by about 1.75 per cent. of salt. The difference in regard to percentage of gypsum, which effects but little the relative commer value, may find a satisfactory explanation, etc. * * * The proport of gypsum obtained by myself is still somewhat less than that contai in the Onondaga brines. Comparing the results of both analyses in reg to the percentage of chlorid of sodium contained in the Goderich brine w that known to be in the average of the brines of Onondaga, (about per cent.) we notice that the Goderich brine in either case exceeds former by about 50 per cent. of salt, or more; while the proportion obnoxious deliquescent chlorids contained in the Goderich brine amou to only one-fourth or one-fifth of that found in the brines of Onondag

Analysis of Goderich salt. "A sample of boiled salt from the Goderich works gave as follows:

Chlorid of sodium	97.0309
Chlorid of calcium	.0072
Chlorid of magnesium	.0313
Sulphate of lime	1.4306
Moisture	1.5000
	100.0000

"This sample of salt, in a dried state, would contain not less than 9 per cent. of chlorid of sodium or pure salt. It ranks, consequently forem

ng the common fine salt (boiled) in the market. In the percentage he deliquescent chlorids of calcium and magnesium, which are consid- d the most obnoxious component parts of brine or salt, it compares most rably with the best foreign and domestic salt. In fact the composition he Goderich brine is such as to warrant, *à priori*, with but little care, perior salt, common, fine and coarse. The commercial value of the e of Goderich, in consequence of its superior purity as compared with brine of Onondaga, is, judging from the previous statements, quite ious. The Michigan (Saginaw) and Ohio River brines, I need scarcely , have still less chance to compete on anything like equal terms."

' The salt," he adds, further on, " is, after separation from the pickle, night have been expected from a brine like the Goderich, of a superior r, and of a hard and fine grain, resembling the best brands of home foreign manufacture, and this result is attained without any but the inary care required for the manufacture of common fine salt. It wil noticed that the sole objection which may be urged against the Goderich e is merely incidental, for the brine is too strong to be worked to its advantage by the system of manufacture at present pursued."

The low price at which English salt is imported makes it probable that **Cost of making.** product of the Goderich region can scarcely compete with it in that part he Dominion to the east of Lake Ontario, while the wells already sunk probably more than sufficient to supply the remaining portion of the ntry. From these considerations it would seem that the only chance a further development of the salt resources of the Goderich region is found in the United States market. The present duty on salt entering t country amounts, however, to twenty-four cents in gold on 100 pounds acked salt, and eighteen cents on 100 pounds of loose salt, making it, n the barrel of 280 pounds, \$0.67 [2] . By a proper system of evapo- ion, either by solar heat, or by a more economical use of fuel, as has n already pointed out, Dr. Goessmann conceives that the net cost of barrel of fine salt, the barrel included (which costs 30c.), should not eed \$0.70, while the freight from Goderich to Chicago would cost 10c.; his he adds for storage, landing, selling, etc., at Chicago, \$0.21½, king the cost of a barrel of fine salt from Goderich, delivered at icago, \$1.68½. This, at the price ruling in January, 1868, would ve a small margin for profit, which might be increased if the salt were pped loose, and thus entered at a reduced duty. For this traffic the ition of Goderich, on the lake, and at the terminus of a railway, offers y great advantages; and, but for the duty against which it has to con- d, it seems probable that the salt region of Goderich, stretching, appar- ly, to Clinton on the one side and to Kincardine on the other, might, m the greater purity and strength of its brines, command the market of north-western United States.

Table giving a comparison of different expressions

Degrees; Salometer.	Degrees; Baumé.	Spcific gravity.	Per cent. of Salt.	Grains of Salt in one pint.	Gallons for bushel of Sa
0	0	1.000	0	0	Infinite.
1	.26	1.002	0.26	19	2599
2	.52	1.003	0.51	38	1297
3	.78	1.005	0.77	56	863
4	1.04	1.007	1.03	75	647
5	1.30	1.009	1.28	94	516
6	1.56	1.010	1.54	114	430
7	1.82	1.012	1.80	133	368
8	2.08	1.014	2.06	152	321
9	2.34	1.016	2.31	171	285
10	2.60	1.017	2.57	191	256
11	2.86	1.019	2.83	210	232
12	3.12	1.021	3.08	229	213
13	3.38	1.023	3.34	249	196
14	3.64	1.025	3.60	269	182
15	3.90	1.026	3.85	288	169
16	4.16	1.028	4.11	308	158
17	4.42	1.030	4.37	328	149
18	4.68	1.032	4.63	348	140
19	4.94	1.034	4.88	368	133
20	5.20	1.035	5.14	388	126
21	5.46	1.037	5.40	408	120
22	5.72	1.039	5.65	428	114
23	5.98	1.041	5.91	448	109
24	6.24	1.043	6.17	469	104
25	6.50	1.045	6.42	489	99.7
26	6.76	1.046	6.68	510	95.7
27	7.02	1.048	6.94	530	92.0
28	7.28	1.050	7.20	551	89.5
29	7.54	1.052	7.45	572	85.3
30	7.80	1.054	7.71	592	82.3
31	8.06	1.056	7.97	613	79.5
32	8.32	1.058	8.22	634	76.9
33	8.58	1.059	8.48	655	74.5
34	8.84	1.061	8.74	676	72.1
35	9.10	1.063	8.99	697	69.9
36	9.36	1.065	9.25	719	67.9
37	9.62	1.067	9.51	740	65.9
38	9.88	1.069	9.77	761	64.1
39	10.14	1.071	10.02	783	62.3
40	10.40	1.073	10.28	804	60.6
41	10.66	1.075	10.54	826	59.1
42	10.92	1.077	10.79	848	57.6
43	11.18	1.079	11.05	869	56.1
44	11.44	1.081	11.31	891	54.7
45	11.70	1.083	11.56	913	53.4
46	11.96	1.085	11.82	935	52.2
47	12.22	1.087	11.08	957	50.9
48	12.48	1.089	12.34	979	49.8
49	12.74	1.091	12.59	1002	48.7
50	13.00	1.093	12.85	1024	47.6

for the strength of Brine from zero to saturation.

Degrees; [S]alometer.	Degrees; Baumé.	Specific gravity.	Per cent. of Salt.	Grains of Salt in one pint.	Gallons for a bushel of Salt.
51	13.26	1.095	13.11	1047	46.6
52	13.52	1.097	13.36	1070	45.6
53	13.78	1.100	13.62	1092	44.7
54	14.04	1.102	13.88	1115	43.8
55	14.30	1.104	14.13	1137	42.9
56	14.56	1.106	14.39	1160	42.0
57	14.82	1.108	14.65	1183	41.2
58	15.08	1.110	14.91	1206	40.4
59	15.34	1.112	15.16	1229	39.7
60	15.60	1.114	15.42	1252	38.9
61	15.86	1.116	15.68	1276	38.2
62	16.12	1.118	15.93	1299	37.5
63	16.38	1.121	16.19	1322	36.9
64	16.64	1.123	16.45	1346	36.2
65	16.90	1.125	16.70	1370	35.6
66	17.16	1.127	16.96	1393	35.0
67	17.42	1.129	17.22	1417	34 4
68	17.68	1.131	17.48	1441	33.9
69	17.94	1.133	17.73	1465	33.3
70	18.20	1.136	17.99	1489	32.7
71	18.46	1.138	18.25	1513	32.2
72	18.72	1.140	18.50	1538	31.7
73	18.98	1.142	18.76	1562	31.2
74	19.24	1.144	19.02	1587	30.7
75	19.50	1.147	19.27	1611	30.3
76	19.76	1.149	19.53	1636	29.8
77	20.02	1.151	19.79	1661	29.4
78	20.28	1.154	20.05	1686	28.9
79	20.54	1.156	20.30	1710	28.5
80	20.80	1.158	20.56	1736	28.1
81	21.06	1.160	20.82	1761	27.7
82	21.32	1.163	21.07	1786	27.3
83	21.58	1.165	21.33	1811	26.9
84	21.84	1.167	21.59	1837	26.5
85	22.10	1.170	21.84	1862	26.2
86	22.36	1.172	22.10	1888	25.8
87	22.62	1.175	22.36	1914	25.5
88	22.88	1.177	22.62	1940	25.1
89	23.14	1.179	22.87	1966	24.8
90	23.40	1.182	23.13	1992	24.5
91	23.66	1.184	23.39	2018	24.2
92	23.92	1.186	23.64	2045	23.8
93	24.18	1.189	23.90	2072	23.5
94	24.44	1.191	24.16	2098	23.2
95	24.70	1.194	24.41	2124	23.0
96	24.96	1.196	24.67	2151	22.7
97	25.22	1.198	24.93	2178	22.4
98	25.48	1.201	25.19	2205	22.1
99	25.74	1.203	25.44	2232	21.8
100	26.00	1.205	25.70	2259	21.6
...	.....	.....	.....	....	....

Explanation of table.

The preceding table is extracted from Professor Alexander Winch
Report on the geology of Michigan, published in 1861. An abstrac
it was given in my Report for 1866, but it has been thought advisabl
re-print it at length as a guide to our salt-manufacturers. Pure w
dissolves at ordinary temperature a little over one-third its weight of
or from thirty-five to thirty-six hundredths. The amount varies somev
with the temperature, and the results of different experiments are m
over not perfectly accordant, but from the most accurate observatio
appears that 100 parts by weight of pure saturated brine, at temperatu
from 32° to 70° F., contain from 26·3 to 26·7 parts of salt. S
earlier determinations however, gave but 25·7 parts, and upon this fig
the table was calculated.

The specific gravity of a saturated brine at 60° F. is 1·205, p
water being 1,000. The salometer employed in many salt-works
fixing the value of brines is an areometer with an arbitrary scale divi
into 100 parts. The density of pure water on this scale is represen
by 0°, and that of saturated brine by 100° ; each degree of the salome
therefore, corresponds very nearly to one-quarter of one per cent
salt. The areometer or hydrometer of Baumé has also an arbitrary sc
but it is an instrument in common use and may conveniently replace
salometer. In the following table the true specific gravity, with the cor
ponding degrees of the salometer, and of the hydrometer of Baumé are gi
in the first three columns. The succeeding columns give the percent
of salt in a pure brine for each degree of the salometer, the numbe
grains of salt to the wine pint of 36·625 cubic inches, and the numbe
gallons of such brine required to yield a bushel of salt, weighing 56 pour
These latter numbers are based upon the supposition that a saturated br
contains only 25·7 per cent of salt, but if we take into account the effec
the small quantities of earthy chlorids and other impurities which ordin
brines contain, they will be found not only sufficiently accurate for
purposes but nearer the truth than if based upon the composition o
perfectly pure brines.

II. IRON AND IRON ORES.

The iron ores of Canada have been described at considerable length in *Geology of Canada*, in 1863, and the Report for 1866 contains farther ices of those found in the county of Hastings, with details as to former eriments in working them, on pages 98–103 and 107–113 ; besides ices of localities on the Ottawa, at page 20, and an account of the mode their occurrence among the Laurentian rocks, which will be found on ges 214–216 of the same Report,

The principal iron ores of Canada are, 1st, the magnetites and hema-s of the Laurentian and Huronian systems ; 2nd, similar ores in the ebec group, in the Eastern Townships of the province of Quebec ; 3rd, bog ores or limonites of recent origin ; and 4th, the iron sands, to which ntion has recently been called. In the above enumeration the provinces Quebec and Ontario are alone included ; the iron-deposits of the pro-es of Nova Scotia and New Brunswick will be made the subject of ire study. It is proposed in the present report to call attention to e facts in the history of the first and the last of these four classes, and ive the results of some analyses of these ores. Classification.

The iron ores of the Laurentian system are, for the greater part, of the netic species, and are similar in geological relations and in mineralo-l characters to the ores which occur in the same system in northern v York, and in the Highlands of southern New York and New Jersey, re they have long been mined to a great extent. Similar ores, more-, abound in Norway and Sweden, where they occur in rocks of the e age, and furnish great quantities of very pure iron, which is famous ughout the markets of the world. Having had opportunities at the osition at Paris, in 1867, to learn many facts about the iron-industry of e countries, I have thought it would be well to embody some of them e present report, as likely to prove valuable to the mining interests of Dominion. A large portion of both Norway and Sweden is occupied Ores of Norway and Sweden. ld gneisses of the Laurentian system, which also comprise the greater of the provinces of Ontario and Quebec. This geological resemblance, somewhat similar conditions of soil and climate, gives to any facts ing to the mineralogy and metallurgy of those northern regions, a special rest to the people of Canada.

the year 1865, according to official data, there were extracted in den 492,474 tons of iron ore, employing 5,062 workmen. The mines penings from which this amount of ore was raised, are stated to be 524 mber, and some of them are evidently worked on a very small scale. workings are ordinarily by open cuttings upon the beds or masses of Working, which are described as being very generally in a nearly vertical atti-

tude, and in solid crystalline rock, requiring but little support by t bering. The mineral is mined with powder, although nitro-glycerine been tried to some extent. The pay of the workmen ranges from thirty fifty cents per day, and the cost of the ore, when raised, is said to vary fr one to two dollars for the ton of 1000 kilogrammes (2205 pounds avoir pois). With the exception of a small quantity carried into Finland, whole of this ore is smelted in the country. The production of iron o in Norway is much less than Sweden ; about 22,000 tons are rai annually, of which 2500 tons are exported, the remainder being smel in blast-furnaces with charcoal. At one of the most important of th that of Laurvig, where a remarkably fine iron is made for the Ameri market, the cost of the ore at the furnace is stated at $1.80 the ton.

Charcoal making.

In Sweden, and in Norway, charcoal is the only fuel employed for reduction of the iron ores, except in some rare instances, where a mixt of charcoal and dry wood has been used in the blast furnace. Car trials, however, appear to show that this admixture offers no advanta over the use of charcoal alone. About one-third of the surface of Swe is covered with forests, which constitute an important source of wealth the country, and of late years have been the object of care and attent with a view to a due economy of fuel and lumber. The trees of the Swe forests, with the exception of the southern peninsula, where oak beech are met with, are chiefly of coniferous or soft-wooded species, the pine of the country (*Pinus sylvestris*) is the one principally used metallurgical purposes, the timber being sawn or hewn for lumber, w the branches are employed for the manufacture of charcoal. The woo cut in the months of March and April, before the rising of the sap, an divided into lengths of about eight feet, which are allowed to dry du the summer months. The charcoal-burning takes place in October November, and is generally carried on in circular piles about twelve high and from twenty to thirty feet or more in diameter. The burnin a pile lasts from two to three weeks from the time of kindling. Ex rience has shown, in Sweden, that the economy is much greater when wood is laid upon its side in the piles than when placed on end. In latter case the yield of charcoal is from 60 to 62 per cent. of the volum the wood, while in the former it is not less than 70 per cent. Accor to a Report to the Swedish Minister of Agriculture, Commerce and P lic Works, published in 1866, the average cost of labor for a pile yi ing from twelve to thirteen tons of charcoal, is 84 francs, which is equa about $1.30 for the ton of 1000 kilogrammes. This price includes cutting and drawing of the wood.

The cubic meter or stere of 35·317 cubic feet of pine charcoal in Swe weighs from 142 to 145 kilogrammes, so that the ton of 1000 kilogram

2205 pounds) would measure very nearly 7 steres, or 247 cubic feet, nd the weight of the cubic foot of charcoal would be a little over 4 kilo- rammes, or 8.8 pounds, nearly. According to figures given by Grill, owever, (Percy, *Metallurgy of Iron*, page 596) a ton of the charcoal ed in the Lancashire hearths, in Sweden, measures not less than 297 bic feet. In the American iron-regions charcoal is bought and sold by e bushel, which is an arbitrary measure of about five pecks, equal, cording to Overman, to 2600 cubic inches, and according to Osborn to 75 cubic inches, (the United-States standard, or Winchester bushel, easuring 2150.42 cubic inches.) Taking the latter figure, we find that e American charcoal-bushel of Swedish pine-charcoal would weigh a tle over 13.5 pounds avoirdupois. Weights of charcoal.

The experiments of François, in the Pyrennees, give for the weight of the bic meter of charcoal of beech and oak, from 218 to 235 kilogrammes, at of alder being 141, and that of pine and spruce from 152 to 173. He duces as the mean for hard-wood charcoal 227, and for soft-wood, 170 ogrammes, corresponding respectively to 21.9 and 16.4 pounds avoir- pois for the charcoal-bushel as above. (Jules François, *Des Min- ais de Fer, etc.*, page 177.) The elaborate studies of Mr. Marcus ll on the charcoal from North American woods, give the following as the ights, in pounds, of a bushel of dry charcoal from these kinds, among ers: red cedar 12.52, white pine 15.42, yellow pine 17.52, white ch 19.15, and several varieties of maple and oak from 21 to 23 pounds.* is last is confirmed by the observation of Mr. Kennedy, at the Hull Iron- ks, who informed me that a bushel of mixed beech and maple, such as re used, weighed from 22 to 23 pounds.

The cubic meter is equal to about 22.8 charcoal-bushels of 2675 cubic hes, and the price of the cubic meter of charcoal, which reaches at some naces, $1.30, is on an average, in Sweden, 85 cents, or about r cents the bushel. At the iron furnace of Laurvig, in Norway, the t of good charcoal is said to from to 60 to 70 cents the cubic meter. Cost of coal.

n a few localities in Sweden, where water-courses afford facilities for ting the wood to the furnaces, the charring is effected in ovens of a uliar construction, furnished with an arrangement for condensing the l and tarry products given off during the process. The plan of one of e furnaces, shown at Paris, in 1867, was similar to that figured by Dr. cy, on page 125 of his first volume on Metallurgy, in which will be d discussed in great detail, the whole subject of charcoal-burning, ages 107-142.

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*These results were pnblished in the Transactions of the American Philos. Society, 826, new series, pp. 1–60, and are reproduced in the American edition of Knapps nology, i, 24.

Although the Swedish ores vary considerably in their richness, it ma be calculated that, in general, about two tons of ore are required for or ton of cast iron, to produce which are consumed on an average about ton of charcoal. It is evident therefore that, for the same cost of pr

Carrying fuel.

duction, the fuel can be transported much farther than the ore. Charco is often carried from localities where wood is abundant, to blast-furnaces the vicinity of mines, a distance of twenty or thirty leagues. This is do in part by water or by rail, but for the transport of the ores from regio not easily accessible at other times, sledges are much used in the winte which becomes the most favorable season for getting both the charcoal a the ores to the furnaces, which are generally as near as possible to t mines. In some cases the ores are carried for distances of ten or mo leagues ; but this is generally when there is a back-freight of iron or oth materials. The wages of a carter, with his horse, vary from $0.80 to $1. per day, and the cost of transporting the ore is from $6\frac{1}{10}$ to $9\frac{6}{10}$ cents t ton for the English mile.

Law concerning mines.

The law with regard to mines in Sweden is as follows : The discover becomes the owner of one-half, while the other half remains the property the owner of the land, who can work it by sharing the cost with the d coverer, or dispose of his share in the mine. A permission to work a n mine must be given by the magistrate ; and if left unworked during a ce tain number of years, without obtaining a special authorization from t magistrate to do so, or without performing annually an amount of lab stipulated as necessary to retain possession of the mine, the permissi lapses, and the mine can be taken up again by another party on the sa terms as a newly discovered one.

Many of these mines are worked on a small scale, by little proprieto who sell their ore, or in other cases join their forces and construct, betwe them, a blast-furnace at a cost of from $12,000 to $14,000. Much the iron manufactured in Sweden has, from the earliest period, been in t hands of peasants and small proprietors. The manufacture of cast iron Sweden goes back about 200 years ; previous to that time wrought iron w made from the ore by a direct method. Those regions where ore and f furnished conditions favorable to mining industry, were formerly cons tuted into districts, which were invested by the state with certain pri leges, and subjected to certain restrictions, one of which was to exp beyond their limits all the cast iron manufactured within their respect districts. All of these restrictions are now, however, abolished.

Blast-furnaces.

The total number of blast-furnaces in Sweden is about 300, of wh 219 were in blast in 1865, and instead of being grouped together, as some other countries, they are, with few exceptions, isolated ; a sin furnace being erected in some spot where a water-power and facilit

transportation are met with in proximity to forests sufficient to afford supply of charcoal, the deposits of ore being pretty widely distri-ted. The amount of ore raised in 1865 has been already stated at 2,474 tons, employing 5063 workmen. The production of the various rnaces in the same year was 226,676 tons of cast iron, employing 83 workmen, whose wages ranged from $0.30 to $1.40 per day.

The ores vary in richness from the nearly pure magnetic or specular es, containing as much as 70 per cent of iron, to those yielding not more an 28 per cent. The Swedish ores and irons have been made the ject of very minute and extended chemical studies, with reference to the per composition of the charges, the nature and quantity of fluxes to be ded, the various impurities in the ores, and the influence of all these on the quality of the iron. Foremost in importance are considered influence of sulphur, phosphorus and manganese. Both sulphur and osphorus are regarded as especially detrimental to the iron destined for forge, or for the manufacture of steel, and from these impurities the edish ores are generally very free, when compared with the ores of gland and France, a purity which they may be said to share in common h the Laurentian ores of North America. The observations which have en made with regard to the Swedish ores, in this respect will, therefore, the most part, be equally applicable to our own. The sulphur of the edish ores is generally present in the form of pyrites or sulphuret of iron, l may be expelled by roasting at a red heat, which completely oxydizes s substance. If, however, carbonate of lime is present at the same e, a portion of sulphate of lime is formed, by which some of the sulphur etained, and can only be removed by subsequent washing with water, in ich the sulphate is slightly soluble. It does not appear whether the of water is ever thus resorted to. The ingenious furnace of West-nn, by which the waste gases from the blast-furnace are employed to ect the roasting and desulphurizing of the ore, is said to have been found roughly efficient in Sweden, and is now in use at Ringwood, in New sey, in connection with a blast-furnace, by Messrs. Cooper, Hewitt and . In some cases the roasting of the ores in Sweden is two or three es repeated. The heat is so great that they are more or less softened, l show a commencement of fusion. The magnetic ores, after this cess, appear to be more readily reduced than before, though the roasting ms, from the result of analyses at Fahlun, to have but little affected the te of oxydation of the iron. The favorable effect is probably due, in t, to the fissuring of the ore by the heat. The presence of even small tions of sulphur in wrought iron renders it, as is well known, brittle en hot, or red-short, as it is termed. For certain purposes, however, the sence of sulphur in cast iron is not objectionable. Thus, for casting

Composition of ores.

Sulphur.

alcination.

cannon, according to Rinman, a very strong metal is obtained by addi to the charge a small amount of sulphuret of iron, and in general for t purpose a charge is preferred free from phosphorus, but somewhat sulph rous. The sulphur causes a larger proportion of carbon to remain ir combined state ; a very tenacious mottled cast iron is obtained, holdi about 0.09 per cent of sulphur, and the quantity may even rise to 0. or 0.50 per cent. The use of sulphurous ores, according to Rinman, li that of manganesian ores, enables us to obtain white iron when the furna is running at its ordinary rate, and without any overcharge of ore.

Phosphorus.

Phosphorus, in like manner, though it renders wrought iron cold-sho gives to it a hardness which renders it peculiarly valuable for so purposes, as for boiler-plates, roofing-sheets, spades, shovels and hoes, a other utensils which are exposed to severe wear. In the metal for the at least 0.1 per cent of phosphorus, and in that for fine castings as much 0.5 per cent, is considered advantageous, as contributing in the latter ca to give greater fusibility and fluidity to the melted metal. But for t manufacture of steel, phosphorus seems to exert a highly prejudic influence, and it appears from carefully-made analyses of Swedish iro that their value in the Sheffield market, where their relative fitness for t manufacture of steel has been determined by experience, is, as shewn Rinman, directly in proportion to their freedom from phosphorus.

The amount of phosphorus in the ores of Dannemora, Bispberg, a some other of the Swedish mines does not exceed 0.005 per cent., while some others, as Gellivara and Graengesberg, it rises to 1.3 and even 2.0 p cent. Some of these ores, like similar ores in northern New York, conta imbedded grains of phosphate of lime or apatite. It is, however, to remarked that the whole of the phosphorus in the charge does not pa into the ores, and moreover, that the proportion of this element varies different parts of the deposit, so that by a judicious admixture of t phosphuretted with purer ores, the resulting cast iron will not conta more than 0.15 per cent. of phosphorus, which does not render it unfit ordinary uses.

Manganese.

Manganese is also conceived to exert an important influence, in mo ways than one, upon the quality of iron. The Swedish ores not unf quently contain a portion of this element, and when absent from any o it is sought to be supplied by mixtures containing manganese. While t greater part of it passes into the slags, a certain portion remains in the ca iron, and to its presence it is customary to ascribe a peculiar fitness in t resulting malleable iron for the manufacture of steel. It is, howeve remarked that manganese is often wanting, without any observed inferio ity in the cast iron.

The presence of titanium, and its influence upon iron, is a subject which h

late been very much debated. While claimed by Mr. Mushet, and some ers, to exert a special and most beneficial influence on the quality of el, this is denied by others. When ores containing titanium are smelted, Titanium. mall portion of this element, amounting in some cases to a little over per cent., passes into the cast metal, and is said to increase its strength, sides giving it a peculiar mottled aspect. It seems, however, "doubtful ether any titanium remains in the bar iron or steel made from such pig n, so that the improvement attributed to the use of titaniferous ore is bably due to some indirect action, rather than to the actual presence of nium in the finished product. The evidence on this point is not suf- ently clear to allow of any positive conclusion being formed." To the ve statement of Bauerman, I may add that I have failed to detect any nium in bloom iron made by the direct method from an iron ore con- ning 16 per cent. of titanium, which will be described further on.

Some remarks upon the composition and the results of analyses of the edish ores may not be without value, as serving for comparison with the n ores of Canada. The iron, both of Sweden and of Norway, is made, h but few exceptions, from ores of the magnetic species. That of the ious Dannemora district, which supplies a great number of blast-fur- Dannemora ore. ces, and produces an iron regarded as superior to all others for the manu- ture of steel, occurs as an irregular interrupted belt, a mile and a half in gth, which is imbedded in crystalline limestone, with a kind of petrosili- us rock, and has been mined to a depth of more than 100 fathoms. The nposition of different portions of the deposit presents considerable varia- n. Average specimens from one of the most important masses, sent to Paris Exhibition in a roasted state, as prepared for the furnace, showed siderable admixtures of silica, lime and magnesia, with some alumina. e sum of the united protoxyd and peroxyd of iron for these two ores, was pectively about 54 and 68 per cent., equalling 38·5 and 48·6 per t of metallic iron. These two ores were almost destitute of sulphur l phosphorus, and had the advantage, when mixed, of yielding usible slag without the addition of any limestone for flux. Others the Swedish ores are much richer in iron than these, while others, l, are very much poorer. Thus, at Taberg, an ore is mined, which Taberg ore. sists of magnetic iron disseminated through a serpentine, (sometimes cribed as a diorite), the magnetic oxyd constituting not more than one f of the mass. This ore, which contains at the same time, from o 10 per cent. of titanic acid, yields only about 25 or 30 per cent of iron. s melted with about one-fourth its weight of limestone as a flux, and es a white mirror-like cast metal, which yields an iron much esteemed for e-drawing. Fuel being cheap in the neighborhood, this ore is exten- ely mined and smelted. Bauerman states that attempts were made to

treat this ore, previously dressed so as to yield 43 per cent of iron, but this purpose it was necessary to bring it to such a finely divided conditi that it was judged better to smelt it in its natural state, the expense to the increased consumption of fuel, being counter-balanced by greater fa lity in treatment. Besides this of Taberg, other similar ores have lo been smelted in Norway and in Finland. The ore from the Cristine m at Krageroë, in southern Norway, is described as a brilliant black titan rous magnetite, not very strongly attracted by the magnet, and intermix with grains of quartz, and of greenish-black hornblende, with a little mag tic pyrites. It contained no phosphorus, but gave by analysis 42.0 cent. of metallic iron, besides 15.10 of titanic acid and 19.9 of silica, w a small amount of earthy bases. Inasmuch as many of our Canadi ores are more or less titaniferous, the following notes with regard to t smelting this and other titaniferous ores are of much interest. They extracted from a communication by Mr. David Forbes, in the *Chemi News* for December 11, 1868.

Working titanic ores.

" The experience of the Scandinavian iron-masters has shown that t only objection to the use of titaniferous ores is that they are found to more refractory in the blast-furnace, in proportion as they cont a greater percentage of titanic acid ; and if much titanium is pres they require a so much larger amount of charcoal to smelt them as not render their employment profitable in a country where other ores free fr titanium can be obtained at a reasonable rate. After considerable ex rience in smelting the ore of Krageroë, which yielded a very good iron was found unprofitable to smelt it alone, for the above reason ; but its was found beneficial when employed in about equal proportions with t other ores of the district, which were free from titanium." Mr. Forb found, in his experience, that by employing a mixture of crushed quartz a limestone as a flux, when the proportion of titanium in the ore did exceed eight per cent, or was reduced to this amount by admixture ores free from titanic acid, no difficulty was experienced in working t ore cleanly and profitably. The iron produced was free from phosphor gave but a trace of sulphur, and only 0·05 of titanic acid, which was su posed to be mechanically present rather than chemically combined with t iron. Another very similar ore from Eger, which contained 38·89 cent. of iron and 7·10 of titanic acid, was found to contain too mu sulphur and phosphorus to be fit for bar iron, but yielded a good foundry- metal, which gave by analysis 0·26 of titanic acid. When smelted alone was refractory, and did not yield a liquid slag, but it was readily fused wh mixed, as at Krageroë, with ores destitute of titanium.

The experience of the iron-masters in New York, who have endeavor to smelt the titaniferous ores of Lake Champlain, generally in admixtu

h other ores, has been very unfavorable, but an attention to the above gestions might probably enable them to overcome the difficulties hitherto ountered. Besides the great bed of ore at Bay St. Paul, holding rly half its weight of titanic acid, Canada has large deposits of ores taining more or less titanium, some of which will be described farther

In the *Geology of Canada*, page 501, I have shown that a massive nular titaniferous ore from St. François, on the Chaudière, in the proce of Quebec, consists of a mixture of about two-thirds of nearly pure gnetic oxyd of iron, and one-third of a titanic iron or menaccanite hold- not less than 48 per cent of titanic acid. The two are, however, dily separable by a magnet, and it is probable that by a magnetic arating machine it will be possible to make use of this and of similar s for the preparation of iron in the direct way, to which the purified gnetic oxyd is well adapted. The iron sands, which contain a large ixture of titanic iron, will be noticed in their place. Titanic ores.

n this connection I quote from Osborn's recently published volume on Metallurgy of Iron and Steel, page 475, the following statements, which gives as a communication from a Mr. Henderson, according to whom an from Norway, holding over 40 per cent of titanic acid, is now sucsfully smelted at Norton, in England, by a process patented by Player New York. The ore is said to be smelted in small furnaces, with a t at 1000° temperature ; 2 tons of coal being required to 2½ tons of ore, with 15 cwt. of limestone, and about 10 cwt. of basalt. The metal thus produced is stated to contain very little carbon, and to be y easily puddled, producing a malleable iron of great tensile strength. h ores are necessarily poor in iron, as compared with magnetic ores, even if they can be readily smelted by the above treatment, it ains to be seen whether their use offers any real advantage.

ANALYSES OF SOME IRON ORES.

The bed of magnetic ore, which has long been known at Hull, is desed in the *Geology of Canada*, page 674. The association of a portion red hematite with the magnetic ore, and of graphite with both, is desed in the Report of the Survey for 1866, p. 216. Since then a large t-furnace has been erected here, which for some time produced a erior quality of pig-iron ; but the working has been since abandoned, economic results not being satisfactory. The two samples whose analyses here given had been prepared for that purpose by Mr. Kennedy, the ctor of the works, and selected so as to represent the average of the smelted. One of these, designated at the furnace as the red ore, was red by an admixture of hematite, while the other was known as the k ore. The red ore gave as follows :— Hull, Ontario.

Hull, red ore.

Peroxyd of iron	66.20	=metallic iron 58
Protoxyd of iron	17.78	
Oxyd of manganese	traces.	
Lime, as silicate	.76	
Magnesia, as silicate	.45	
Carbonate of lime	2.66	
Silica	10.44	
Graphite	.71	
Phosphorus	.015	
Sulphur	.280	
	99.295	

The black magnetic ore of Hull contains a considerable amount of sili together with a portion of a hydrated silicate of iron and magnesia, wh causes the ore to yield an olive-brown powder. When the magne portion is removed from the pulverized ore by a magnet, there remains considerable proportion of dull olive-colored earthy matter, which gives pale brown streak, and is readily attached by hydrochloric acid, with se ration of flocculent silica. In the following analysis of an average sam of the ore the whole was treated together, and all of the iron is represent as magnetic oxyd. Neither of the ores from Hull yielded any titanic ac and the black ore contained neither lime nor manganese. It gave

Magnetic oxyd of iron	73.90	=metallic iron 53.2
Magnesia	1.88	
Alumina	.61	
Silica	20.27	
Water	3.27	
Phosphorus	.027	
Sulphur	.085	
	100.042	

The height of the Hull blast furnace is 38 feet, its diameter at boshes being 10 $\frac{3}{4}$ feet, and at the throat 4 $\frac{5}{12}$ feet; the twyers are six number. The charge at the time of my visit, in August 1868, consisted 19 bushels of hard-wood charcoal, 450 pounds of the above ores, previou calcined, and mixed in equal proportions, and 110 pounds of flux consisti of white crystalline limestone 65, clay 27, and silicious sand 18 pounds. T furnace was then yielding gray pig-iron, at the rate of 56 per cent for t ore, while the consumption of charcoal for the ton of metal, was 170 bushe This was made from beech and maple, and as I was informed by M Kennedy, weighed from 22 to 23 pounds to the bushel, being at the ra of 34 or 35 cwt. of charcoal to the ton of iron.

Furnace-charge

The furnace was for a time in blast in 1867, and for a longer peri

1868. By the kindness of Mr. Phillip S. Ross, the secretary to the nada Iron-Mining and Manufacturing Company, I have been furnished h a statement of the working results during that season.

Working at Hull.

The furnace was in blast from April 27 to October 5, 1868, or 163 s, during which time there were consumed as follows :—

Hull ore	$1835\frac{17}{20}$ tons.	1896 tons.
Arnprior (McNab) ore	$60\frac{3}{20}$ tons	
Scrap iron		$7\frac{4}{20}$ "
Limestone (clay and sand not estimated)		211 "
Charcoal, soft wood at $4\frac{1}{2}$c	133.573 bushels.	242,782 bushels.
" hard wood at 8c.	95.947 "	
" mixed wood at $5\frac{1}{2}$c	13.262 "	
Wood at $1.25		$25\frac{1}{2}$ cords.
Peat, 80 tons, yielding of coke		$21\frac{13}{20}$ tons.
Pig iron produced		$1,040\frac{3}{20}$ "

The cost of the iron thus produced was as follows, per ton :—

For ore, fuel, and wages of men	$22.60
Salaries and general expenses	3.10
Cost of a ton of pig iron at Hull	$26.50

f we deduct from the total amount of metal produced, the scrap iron ed, we obtain, as the average results during the season of 1868, the wing figures :—

Daily production of pig iron	$6\frac{1}{3}$ tons.
Yield of ore per ton	54.5 per cent.
Charcoal consumed per ton of iron (at $5\frac{78}{100}$ cents.)	235 bushels.
Peat-coke " " "	47 pounds.

f we leave entirely out of the account the amount of peat-coke, and take average weight of the charcoal at 18 pounds to the bushel, we shall e a consumption of $37\frac{3}{4}$ cwt. of charcoal to the ton of iron, while, with l-wood charcoal, there were consumed, as above, from 34 to 35 cwt. Sweden, according to Bauerman, the average consumption of charcoal, he whole country, is from 16 to 17 cwt., for the ton of white or mottled ron, and about one-third more, or from 21 to 22 cwt., for the ton of metal suitable for foundry purposes or for Bessemer steel. At gshytta, the consumption is as low as $13\frac{1}{2}$ to 14 cwt., for the production of white or mottled iron, while the very poor ores of Taberg, already rred to (page 251), where the charge contains only 20 per cent of , require as much as 50 or 60 cwt. of charcoal per ton.

American furnaces.

At the Greenwood furnace, near Marquette, on Lake Superior, i
charcoal furnace in which the unroasted ores of the region are smel
with a little crystalline limestone for flux, and yield 55 per cent of i
To produce a ton of gray pig iron are consumed 140 bushels of charc
chiefly of maple, weighing from 16 to 20 pounds each, or about 23 cwt
charcoal. At the Wyandotte works, near Detroit, where the red s
hematite of Lake Superior is smelted, and yields on an average 65 per c
of iron, there are consumed 140 bushels of soft-wood charcoal, weigh
14 pounds to the bushel, or 17½ cwt. to the ton of iron. (Bauerm
Metallurgy of Iron, p. 206). The recent returns from American bl
furnaces, published by Prof. Egleston, of the School of Mines, New-Yo
show that while many American charcoal-furnaces are still working i
very wasteful manner, the consumption of charcoal in some in New Y
and Michigan, is as low as 100 and 105 bushels. At the large bl
furnaces of Port Henry, on Lake Champlain, where magnetic ores simila
that of Hull are smelted with anthracite coal, the average consumptio
from 1.10 to 1.14 tons, equal to 22 or 23 cwt. of anthracite to the to
pig iron.

With these facts before us, it is clear that the rich ores of Hull, w
proper management, should be smelted with 22 or 23 cwt. of charc
instead of from 35 to 38 cwt., the quantity actually consumed. T
alone is sufficient to explain the failure to produce iron profitably at H
where the supply of rich ore is abundant, and the quality of the i
made was excellent.

It is evident from the analyses of the ores above given that the addi
of sand and clay to the charge was unnecessary, and that limestone alo
in proper proportion, would have been sufficient for the purposes of a f

Hull iron.

A series of samples of pig iron made at the Hull furnace, was taken
me for analysis, but the results not being yet complete, are reserved f
future report. It may be stated however that a sample of the white i
made with a mixture of peat-coke and charcoal, contained 0.085 of ph
phorus and 0.28 of sulphur. This amount of sulphur may be due to
considerable proportion which, in the form of sulphate of lime, I h
found in the ashes of some Canadian peats.

St. Maurice.—In the well known blast-furnaces of Messrs. McDougal
St. Maurice, near Three Rivers, in the province of Quebec, where
bog ores of the region are smelted with a hot blast, the charge cons
of 500 pounds of ore, with 25 pounds of limestone, and 16 bushels
mixed charcoal. The results for the month of December, 1868, showe
consumption of 26,272 bushels of charcoal and 372 tons of ore, wit
yield of 163¼ tons of iron, of which about eleven-twelfths were soft g
pig. This gives a production, for the ore, of 43 per cent of iron, wit

umption of 161 bushels of charcoal to the ton. The results of several yses of the ores of this vicinity, made by me in 1852, are given in *Geology of Canada*, page 511, and show them to contain more or manganese, and a considerable proportion of phosphates. The ana- of a specimen of grey pig iron made at St. Maurice, in 1868, gave the following results for 100 parts. St. Maurice, Quebec.

Iron	not determined
Graphite	2.820
Carbon, combined	1.100
Sulphur	.025
Phosphorus	.450
Silicon	.860
Manganese	1.240

he average produce of the St. Maurice forges is about eight tons of daily, which is employed for foundry purposes, and is much esteemed railway wheels. Some four years ago, a small quantity of wrought was manufactured from it, in a hearth-refinery, but the quality of the luct was somewhat irregular, and the manufacture was abandoned. proposed, in a subsequent report, to give the results of farther studies ıese and other irons.

outh Crosby. A large deposit of magnetic iron ore is found on an ıd in Mud Lake, on the Rideau Canal, in the township of South Crosby, not far from Newborough. (See *Geology of Canada*, page 674.) siderable quantities of this ore have been mined, and shipped P itts-, and to Chicago, for use in puddling-furnaces. This ore, however ains, besides an admixture of chloritic matter, a considerable proportion tanum, and more or less sulphur in the form of disseminated grains of tes. The specimen selected for examination was from a large block to the Museum of the Survey, by the Messrs. Chaffey, some years e. Its analysis showed the presence of considerable amounts of nina, magnesia and water, which belong to the intermingled chloritic eral. The iron is calculated as magnetic oxyd, although a portion, ertain in amount, doubtless exists as protoxyd, in combination with the ic acid, and with silica, besides that which enters into the composition ıe sulphuret of iron present. An average sample yielded as follows ; South Crosby, Ontario.

Magnetic oxyd of iron	69.77	= metallic iron 50.23.
Titanic acid	9.80	
Magnesia	4.50	
Alumina	5.65	
Silica	7.10	
Water	2.45	
Phosphorus	.085	
Sulphur	1.520	= pyrites 2.85.
	100.875	

An analysis of another portion of this ore, by Dr. A. A. Hayes of Bos gave 1.49 of sulphur, 5.04 of silica, 4.42 of magnesia, and 16.45 of tit acid. When the pulverized ore is treated with a magnet, it is parti purified, the non-magnetic portion retaining the sulphur, and a large of the titanum. The magnetic portion equalled 74.2 per cent, and tained 54.76 per cent of metallic iron and 5.70 of titanic acid.

North Crosby.

North Crosby. A specimen of iron ore examined from what is sai be a large deposit on the land of Hon. George W. Allan of Toro is a bright crystalline magnetite, free from any visible trace of pyrites, containing but a small amount of sulphur. Its analysis gave

Magnetic oxyd of iron	90.14	= metallic iron 64.9
Titanic acid	1.03	
Oxyd of manganese	traces.	
Alumina	1.33	
Lime	.82	
Magnesia	.84	
Insoluble	5.25	
Phosphorus	.007	
Sulphur	.120	
	99.537	

The protoxyd and peroxyd of iron in this ore were separately determin and found to be exactly in the proportions required by theory for magnetic oxyd. The insoluble residue was chiefly white quartz, wit little black mica and green pyroxene; it was found in another specin to equal 10.80 per cent. This is a very fine and valuable ore, and deposit would seem to be worthy of careful examination.

Belmont.

Sand-pit ore.

Belmont. The great deposits of iron ore at Belmont have been cribed in the *Geology of Canada*, page 676 and in the report for 18 page 100. Since that time, extensive mining operations have there b carried on, and the ore has been shipped to Pittsburg, Pennsylvania. M of this was found objectionable, on account of the considerable proport of sulphur which it contained, but an excavation made in the immediat the former workings, and on what is called the Sand-pit bed, has yielde much purer ore, to which reference is made in Mr. Vennor's Report this volume, page 161. I obtained, by crushing several fragments of ore, taken from a pile at the furnace of Messrs. Shoenberger & Blair, Pittsburg, Pennsylvania, what seemed an average sample. It was reddi from an admixture of hematite, and yielded

Magnetic oxyd of iron	72.80	= metallic iron 52.41
Magnesia	6.46	
Lime	.35	

Carbonate of lime	2.40
" " magnesia	.84
Water	3.50
Insoluble	14.73
Phosphorus	.035
Sulphur	.027
	101.142

'he analysis of another sample of the Sand-pit ore gave of metallic iron 99, water 3.65, carbonate of lime 8.03, carbonate of magnesia 0.48, insoluble residue 16.52. The carbonates were removed, in both lyses, by acetic acid. The ore contains a considerable admixture of a nesian silicate decomposable by hydrochloric acid, so that the insoe residue contains a proportion of soluble silica, which, in the second lysis here given, was equal to 4.25 per cent. The remainder was a silicate iagnesia, iron and a little lime, approaching to pyroxene in composition. determinations given in this paragraph are by my chemical assistant, Gordon Broome.

Iadoc. The Seymour ore-bed in Madoc is described in the *Geology of iada*, page 675, and is further noticed in the Report for 1866, page 98. 'as formerly mined and smelted to a small extent, and is a fine grained netite, free from pyrites. The analysis gave me Madoc.

Magnetic oxyd of iron	89.22 = metallic iron 64.23.
Insoluble	10.42
Phosphorus	.012
Sulphur	.073
	99.725

'he solution of the ore in hydrochloric acid held neither lime nor manese. The insoluble residue was decomposed by heating with a mixture uorid and sulphate of ammonium, and gave magnesia 17.15, lime 11.01, oxyd of iron 11.95, silica, by difference, 59.89. This is the compoon of actinolite, a mineral which is occasionally found in radiating ses in the midst of the ore.

IcNab. The hematite of McNab is described in the *Geology of iada*, page 677. It has been mined to some extent, and shipped to the ted States, and was also used in a small amount at the Hull ironiace in 1868, as already described. It is a purplish-red compact or ly crystalline ore, and holds small quantities of silicious matter and of oonate of lime irregularly disseminated. An analysis by me made in 7, and cited in the Geology of Canada, gave peroxyd of iron 84.10, oonate of lime 8.80, silica 4.00. A more complete analysis of another cimen has since given me as follows : McNab.

McNab.

Peroxyd of iron	84.42	=metallic iron 59.
Carbonate of lime	5.40	
" " magnesia	1.05	
Insoluble	7.16	
Phosphorus	.030	
Sulphur	.065	
	99.125	

Gros Cap.

Gros Cap, Lake Superior. The deposit of hematite which occurs Gros Cap, on the north side of Michipicoten Harbor, has been describec Mr. Macfarlane in the report for 1866, page 130. A specimen of the selected by him, was submitted to analysis, with the following results.

Peroxyd of iron	86.80
Insoluble	12.75
Phosphorus	traces.
Sulphur	.092
	99.642

This ore contained no lime, and the insoluble residue, which was wh appeared to be pure silica.

Bay of Seven Islands.

Bay of Seven Islands. On a small stream known as the Ra River which empties into the Bay of Seven Islands, there occurs, a hundred yards from its mouth, a great mass of iron ore imbedded in norite or labradorite rock of the country. The ore, with the exceptio an occasional included portion of norite, appeared to occupy the bed both banks of the stream for a breadth, east and west, estimated at ab 500 yards, and is said to extend for some distance north and south, owing to a heavy storm at the time of my visit, its limits were not ascertair The ore is black, brilliant and somewhat coarsely granular. It holds imbed grains of feldspar, with what appears to be pyroxene, and some i

Titanic iron ore.

pyrites. Although pretty strongly magnetic, it contains a large amoun titanium, a partial analysis of an average sample yielding for 100 parts

Protoxyd of iron	49.77	=metallic iron 38.7
Titanic acid	34.30	
Insoluble	6.35	
	90.42	

The other bases, derived from the admixture of silicates, were not det mined. When pulverized and treated by a magnet it was separated i two portions, one strongly magnetic, equal to 57 per cent. The remain gave by analysis 51.14 of titanic acid, and 39.75 of peroxyd of ir

des 8.30 of insoluble residue. The magnetic portion, contrary to what ht have been expected from the readiness with which it was attracted he magnet, contained not less than 24.80 per cent of titanic acid. It nearly free from silicious impurities, and almost wholly soluble in rochloric acid. The existence of a highly magnetic compound, con-ing so large a proportion of titanum, is interesting, and the substance rves further study,—meanwhile, as an iron ore, it must take its place the highly titanic ores, like that of Bay St. Paul, to which reference already been made. Should it ever be found advantageous to work ores, the deposit at the Bay of Seven Islands may be made to ish a very large quantity.

IRON SANDS.

he silicious sands of most regions contain a greater or less proportion eavy black grains, which consist chiefly of some ore of iron. The ce of these is easily traced to the crystalline rocks which, by their Black sands. tegration, have given rise to the sands, and which, in addition to occa-l beds or masses of iron ores, generally hold disseminated grains of netite, hematite, titanic iron (menaccanite or ilmenite of mineralogists) more rarely chromic iron ore. In the process of washing earth and for gold, diamonds, or tin ore, considerable quantities of these black sands are met with, and, from their high specific gravity, remain when ighter portions are washed away. The chromic iron ore is compara-y rare, and confined to certain districts; the hematite, with the ption of some crystalline varieties, is generally too soft to resist the ling forces which have reduced the solid rock to sand, so that the grains, in most districts, consist chiefly of magnetic and titanic iron

In the gold-bearing alluvions of the Chaudière region in Canada, ands obtained in washing for gold, when purified as much as possible Gold alluvions. ashing, were found to hold eighteen per cent. of magnetic iron. The nagnetic portion was soluble in acids and fused bisulphate of potash, the exception of 4.8 per cent. of silicious residue, and the solutions ined, besides iron, a considerable proportion of chromium, and 23.15 ent. of titanic acid, derived from the titanic iron ore, which made up ge portion of the sand. (*Geology of Canada*, page 520.)

e proportion of these ores to the whole mass of ordinary silicious is, generally, by no means large, but the action of moving water s a concentration of the mixture, separating the lighter silicious grains or less completely from the heavier portions, which consist chiefly of on ores, generally with a small quantity of grains of garnet. This ation is effected, on a large scale, by the action of the sea, under the

influence of the winds and tides, and the result of this action occasionally gives rise to remarkable accumulations of these heavy iron sands, along the present sea-beaches. A similar process in past ages, during the deposition of the stratified sands, which are now found at heights above the sea level, has sometimes arranged the iron grains in layers, which are seen to alternate with the lighter silicious sands, as in the deposits of to-day.

Iron-sand beds.

Accumulations of these iron sands are met with in many countries They are found on the shores of Great Britain, along the borders of the Baltic and the Mediterranean, and abundantly on the coast of New Zealand In some parts of Hindostan and Madagascar the grains of iron ore ar extracted by washing from the sands of the country, and employed by th natives in their primitive furnaces, for the manufacture of iron on a smal scale. The iron sands of New Zealand have of late attracted particula attention from their great extent and richness. According to Hochstetter the shore of the northern island from Kaipara to Taranaki, a distance o 180 miles, is bordered with a thick layer of iron sand, which contains according to different analyses, from six to eleven per cent. of titanic acid

New Zealand.

In North America, black iron sands abound in many places. They occu in great quantities in the lower St. Lawrence, as will be hereafte described, and are met with, in smaller amounts, at various points to th south-westward, along the valley of the St. Lawrence and the great lakes Thus, a deposit of black sand at the outlet of Lake Huron, near Sarnia attracted some attention, a few years ago; while along the north shore o Lake Erie this sand is, in some places, found in such quantity that attempt were, it is said, made, more than twenty-five years since, to collect it an smelt it with an admixture of bog ore, which was then treated in a blas furnace, at Normandale, Norfolk county, Ontario.

Western lakes.

These black sands are likewise met with at various points along th coast of the United States, particularly on the shores of Connecticu where they early attracted the attention of the colonists, and were su cessfully worked more than a century since. The following details relatin to the history of these early and little-known trials, are so interesting th I may be pardoned for introducing them here. It appears by a letter fro Mr. Horne, a steel-maker and cutler of London, addressed to Mr. Joh Ellicot, F.R.S., and read before the Royal Society of London, March 1763, that, at that time, the Society for the Encouragement of Arts a Manufactures was occupied with the question of the Virginian black san as it was called. Already, before 1742, one Dr. Moulen, of the Roy Society, had made some unsuccessful experiments to determine the natu of this magnetic sand, but in that year Mr. Horne, having procured quantity of it, succeeded, as he tell us, in extracting from it more than on half of its weight of fine malleable iron. He seems, however, to have pu

Early workings

lished nothing upon the subject until after Mr. Jared Elliot had made known, twenty years later, by a pamphlet and a letter addressed to the Society of Arts, and subsequently by a letter in reply to Mr. Horne's inquiries, that he was then making malleable iron from the black sands, in blooms of fifty pounds and upwards, by direct treatment in a common bloomary fire, a process which seems, from his letters, to have been one familiar to him. He describes the ore as yielding 60 per cent. of malleable iron, and as being very abundant, and so free from impurity as to require the addition of cinder or of bog ore. This manufactnre of iron from the sand had evidently been somewhat developed, for, according to Mr. Elliot, his son had already erected a steel-furnace, before the Act of Parliament was passed prohibiting the manufacture of steel in the colonies. Specimens of the steel there produced were examined by Mr. Horne, and found to be of excellent quality, very tough, and not at all red-short.* Elliot's trials.

Throughout the essay of Mr. Horne the sand-ore is spoken of as coming from Virginia, a name which in the reign of Elizabeth was given to the whole American coast from Canada to Florida, although in 1643 the name of New England was applied to the region which still bears that name. It appears, however, that the so-called Virginia sand was from the coast of Connecticut. Mr. Elliot's letter to Mr. Henry Horne was dated Killingworth, Oct. 4, 1762. Killingworth is a town in the state of Connecticut, on the shore of Long Island Sound, twenty-five miles east of New Haven, and was the residence of the Rev. Jared Elliot, D.D., who was not only a divine, but a physician, and a naturalist of great repute. It is recorded of him that "some considerations had led him to believe that the black sand, which appears originally on the beach of the sound, might be wrought into iron. He made an experiment upon it in the year 1761, and succeeded. For this discovery he was honored with a medal by the society instituted in London for the Encouragement of Arts, Manufacturers and Commerce." * Connecticut.

Notwithstanding this successful result, the iron sands seem to have been neglected for the last century, both in America and in Europe. We read, it is true, that such sands are treated in open hearths (bloomaries) at Avellino, near Naples, and within a few years attempts have been made in England to turn to use the iron sands of New Zealand; but the first successful attempts in this country were on the north shore of the lower

* These curious details are extracted from a rare volume entitled *Essays concerning Iron and Steel*, (the first of the three essays being on "The American Sand-Iron,") by Henry Horne, London, 1773. 12mo., pp. 223. A copy of this scarce book is in the possession of W. M. B. Hartley, Esq., of New York.

* Barber's *Historical Collections of Connecticut*, page 531. The Rev. Jared Elliot, who was a grandson of the celebrated John Elliot of Massachusetts, the "Apostle of the Indians," died in 1763, aged seventy-eight years.

St. Lawrence. The great deposits of black iron sand on the beach near the mouth of the Moisie River, having attracted attention, various attempts to reduce it were made. In January, 1867, Mr. W. M. Molson of Montreal, had the ore successfully treated by the bloomary process, in northern New York, and the result proving satisfactory, several bloomary furnaces were, in 1867, constructed by him at Moisie, and have since been in successful operation.

Moisie.

It will here be well to notice the nature and the composition of the iron sand at Moisie, as observed by myself in the summer of 1868. The stratified sands at Moisie, lying about ten feet above high-water mark, penetrated by the roots of small shrubs, and holding marine shells, were observed to be banded by irregular dark colored layers, in which the iron ore predominated. The same thing was afterwards remarked by me in stratified sands at much higher levels in the vicinity. Where these sands form the beach, they are exposed to the action of the waves, which effect a process of concentration, on a grand scale, so that, it is said, after a prevalence of certain winds, great belts of nearly pure black sand are exposed along the shore. At the time of my visit trenches were being sunk to a depth of five feet, on the shelving beach, about half-way between high and low-water mark. The sections presented alternations of nearly pure silicious sand and of black iron sand, the latter in layers of from half an inch to six inches in thickness, often with a small admixture of grains of red garnet, which sometimes formed very thin coatings upon the surface of the black layers. One of these latter, six inches in thickness, was taken up by myself, and found to be very pure, as will be seen from its analysis, farther on. It was easy, from these trenches, by means of shovels, to remove, without much admixture, the thicker layers of the moist black sand, which would measure from one and a-half to two feet out of the five feet excavated. This material was piled upon the beach, and afterwards carried to the washing-table. The supplies of sand-ore have hitherto been obtained from the deposits of wet sand below high-water level. Those at the surface, on the beach, have doubtless been recently moved by the waves, but from the inspection of the layers in the trenches, I was led to the opinion that they were lower strata, similar to those seen above the high-water mark, and, like them, of considerable antiquity. They were found to contain marine shells in a crumbling and decayed condition. It is said that these mixed sands of the higher levels yield, on an average, by washing, about fifteen per cent. of black iron sand. When this poor sand is spread upon the shore, and exposed to the action of the waves and the tide, it is found to become concentrated through the washing-away of the silicious grains. This process helps us to understand the mode in which the irregular layers of rich iron sand have been formed in the

midst of the deposits of silicious sand, in the strata which are now above the sea-level.

Washing the sand.

The washing of the ore at Moisie, preparatory to smelting, is done upon a shaking-table, about twenty feet long and four feet wide, with a sloping and somewhat concave bottom. Upon this, by the aid of a gentle current of water, a large part of the lighter grains, chiefly of quartz, are washed away.

Specific gravity.

The specific gravity of the sand, in bulk, was determined by weighing 100 measured cubic centimeters of it, equivalent to 100 grammes of water; and the proportion of grains of magnetic ore was also determined. Of three specimens from Moisie; A was an average sample of several hundred tons gathered in the manner just described, preparatory to washing; B, a portion taken by myself from a layer six inches thick, about three feet below the surface of the beach; and C, the washed ore, as prepared for the bloomary fire. In this connection are given the results of some similar determinations with iron sands from other localities.

	Specific gravity.	*Magnetic.*
Moisie, A	2.82	46·3 per cent.
Moisie, B	2·88	49·3
Moisie, C	2·97	52·0
Mingan	2·84	48·3
Bersimis	2·81	34·3
Natasquan	—	55·7
Kagashka	—	24·0
Batiscan	—	55·0

The specific gravity of the silicious sand with which these iron sands are associated, was found, when determined in bulk, as above, to be about 2.00. It consists chiefly of quartz, whose real specific gravity is about 2.65; that of magnetic iron ore being about 5.18, while the titanic iron ore is about 4.70, and the associated garnet not far from 4.0. The amount of material removed in the process of washing at Moisie is not very great, as may be seen by comparing the proportion of magnetic grains in A and C, the Moisie sand before and after washing. The latter was found by analysis to contain about 5.5 p. c. of insoluble matter, chiefly silicious sand, the remainder being almost entirely oxyd of iron and titanic acid.

The sand of Batiscan, mentioned above, had been purified by washing. Considerable deposits near Champlain, contain, according to Dr. Larue, about 10.0 per cent. of magnetic ore, the remainder being chiefly silicious sand. The specimens from Bersimis, Mingan, Natasquan and Kagashka, however, though collected, as I was informed, without washing, compare favorably with those from Moisie, and, with the exception of Bersimis, even

surpass it in the proportion of magnetic ore. I am indebted for all of these to Dr. Larue, the professor of chemistry in Laval University, Quebec, who has paid much attention to the iron sands of the lower St. Lawrence, and collected himself the specimen from Bersimis, of which locality he has given me some interesting notes. Besides the considerable accumulations of sand on the beach, he observed, about three feet above high-water mark, two layers of black sand, holding about 30 per cent. of magnetic ore, and separated by a stratum of four inches of a gray sand containing very little iron. The three layers were traced with considerable regularity for 1000 feet along the shore. As we have seen, the sand from the beach at Bersimis contained but 34.3 per cent. of magnetic ore, and had a specific gravity of 2.81; the magnetic portion had, however, a specific gravity of 2.99, and the non-magnetic 2.77. The analyses of both of these will be found farther on.

Bersimis.

A deposit of black sand, said to be equal in richness to that of Moisie, is described as stretching along the coast, nearly the whole distance from the Bay of Seven Islands to the mouth of the Moisie River. The sand from Mingan, which is mentioned above, and of which an analysis will be given farther on, is said to be from the west side of the St. John River, at Mingan, but is described as stretching from thence for a distance of three leagues along the coast, and as being very abundant. The deposits of sand at Natasquan and at Kagashka are also stated to be very extensive, and like Mingan, favorably situated for the loading of vessels.

Bay of Seven Islands.

Mingan.

An inspection of the iron sands from the various localities above mentioned, shows that they all contain, besides the ores of iron, a small proportion of red garnet, and more or less of fine silicious sand. The latter of the two substances it is possible to remove almost entirely by careful washing of the crude ore. The use of a magnet enables us to separate the black iron ore grains into a magnetic portion, which is nearly pure magnetic oxyd, and a non-magnetic portion, which is chiefly titanic iron, but, in the specimens submitted to examination, holds a portion of silicious matter, which the imperfectly washed sand still retains. In thus separating the ores into two portions for analysis, the magnetic grains were taken up by a magnet, the poles of which were covered by thin paper, and this process was repeated until the non-magnetic grains were, as far as possible, left behind. The two portions of the ore thus obtained were analyzed separately, the solvent used being, in both cases, hydrochloric acid, which, as is well known, dissolves magnetic oxyd of iron with great facility, and, with certain precautions, may be advantageously employed to dissolve titanic iron ore. For this purpose the non-magnetic portion, having been very finely powdered and sifted, is left to digest with about ten times its weight of hydrochloric acid of specific gravity 1.19, or thereabouts, for

Magnetic separation.

several hours, or until the undissolved residue is no longer black, but grayish or brownish in color. If the process has been conducted with care, and without over-heating, the whole of the iron, and all of the titanic acid which was combined with it, will be found in solution, and may be separated by the ordinary methods. The residue, apparently, contains little else than grains of quartz, with a small proportion of garnet. The finely pulverized ore may also be fused with bisulphate of soda, a process which is more expeditious, and yields equally good results with the last. Chemical analysis.

Moisie.—A specimen of unwashed black sand from Moisie, holding 49.1 per cent of magnetic grains, was decomposed by digestion with hydrochloric acid, and the residue fused with bisulphate of soda. The titanic acid having been thrown down, by boiling, from the united solutions, the iron was directly determined, the other bases being neglected in this partial analysis, which gave me the following results :— Moisie sand.

I.

Protoxyd of iron................	70.10	= metallic iron 55.23
Titanic acid....................	16.00	
Insoluble, chiefly quartz	5.92	
	92.02	

A part of the iron in these ores is in a higher state of oxydation than here indicated, but the determination of the degree of oxydation of the iron in titanic ores is difficult, and, as even the magnetic portion of the sands contains some titanic acid, it is thought advisable, in the present analyses, to represent the whole of the iron in these ores as protoxyd, giving, at the same time, the amount of metallic iron, and, in the case of the magnetic portions, the magnetic oxyd corresponding thereto. In the non-magnetic portion of the Bersimis sand, however, as will be seen, the proportions of the two oxyds of iron were determined. The magnetic grains having been removed from the above sample of Moisie ore, the non-magnetic portion gave 58.20 of protoxyd of iron, 30.74 of titanic acid, and 6.14 of insoluble residue.

Further and more complete analyses were subsequently made of the washed ore from the Moisie iron-works, which, as already stated, contained 52.0 per cent. of magnetic grains. These were analyzed separately, (II) while the non-magnetic portion gave me the results under III. Sulphur and phosphorus are present in this sand in very small quantities, the determinations of Mr. Broome giving for the washed mixed ore .070 per cent. of sulphur and .007 of phosphorus.

Moisie sand.

	II.	III.	1 A.
Protoxyd of iron	85.79	56.38	71.08
Titanic acid	4.15	28.95	16.55
Oxyd of manganese	.40	1.10	....
Lime	.90	.95	....
Insoluble	1.95	8.75	5.35
	93.19	96.13	....
Magnetic oxyd of iron	92.68	....	....
Metallic iron	66.73	43.85	55.27

The sum of the analysis II, if the iron be calculated as magnetic ox i 100.08. The composition of the mixed ore, if we suppose II and to be mixed in equal proportions, would be as under I A, which agr closely with the analysis I, given above.

Bersimis sand.

Bersimis.—The iron sand of Bersimis, as already described, contai but 34.7 per cent of magnetic grains; the analysis of this portion is gi under IV.

	IV.
Protoxyd of iron	85.56
Titanic acid	3.40
Oxyd of manganese	undet.
Lime	traces.
Magnesia	...
Insoluble	3.85
	92.81
Magnetic oxyd of iron	92.44
Metallic iron	66.56

The sum of the analysis, if the iron be calculated as magnetic oxyd 99.67. The non-magnetic portion of the Bersimis sand was dissolved hydrochloric acid, out of contact with oxygen, and the amounts of proto and peroxyd of iron were separately determined. The analysis gave as follows:—

	V.
Protoxyd of iron	24.66
Peroxyd of iron	22.24
Titanic acid	26.95
Oxyd of manganese	1.10
Lime	1.12
Magnesia	.72
Insoluble	23.80
	100.59
Metallic iron	34.94

lingan.—The iron sand from the mouth of the St. John river, at gan, contained 48.3 per cent. of magnetic grains, whose analysis is n under VI, while that of the non-magnetic portion of the ore is d under VII. Mingan sand.

	VI.	VII.
Protoxyd of iron	80.46	46.31
Titanic acid	6.50	31.60
Oxyd of manganese	.52	1.35
Lime	.75	1.06
Magnesia	.70	.50
Insoluble	4.20	15.50
	93.13	96.32
Magnetic oxyd of iron	86.92	....
Metallic iron	65.58	36.00

he sum of the analysis VI, if the iron be estimated as magnetic oxyd, 9.59.

1 the above analyses of the iron sands it will be remarked that the netic portion retains a little adherent silicious matter, and small amounts tanium, both of which vary in the sands from different localities, ough the separation by means of the magnet was in all cases effected the same precautions. Observations and experiments on other samples iese sands go to show that different layers from the same locality vary, only in the proportion of silicious sand, but in the relative proportions agnetic and titanic ores and of garnet. This might be expected when consider that the differences in density between each of these constits of the sand, should, under the influence of moving water, lead to r partial separation from each other. Varying composition.

specimen of iron sand from Quogue, on the south side of Long Island, New York, where these sands are about to be employed for the manuire of steel, closely resembled those of Bersimis, and contained 31 per . of magnetic grains. The unpurified ore, which was mingled with a iderable amount of quartz sand, and some garnet, amounting together bout 17 per cent., gave by analysis about 40 per cent. of iron, and 15 cent. of titanium, besides a proportion of manganese greater than iron sands from the lower St. Lawrence.

)N THE MANUFACTURE OF IRON AND STEEL BY DIRECT METHODS.

lthough by far the greater part of the wrought iron and steel now l in the arts is made from cast iron produced in the blast-furnace,

the history of iron-making shows us that in early times malleable ir even steel, were obtained directly from certain ores, without the p production of cast iron, and without fusion. The manufacture and the latter, in fact, date only from a comparatively recent period natives of India, Burmah, Borneo, Madagascar, and some parts of practice the direct conversion of iron ores to the metallic state i furnaces. In certain districts of India the amount of malleable ir produced is very considerable, and much of it is manufactured into but the furnaces used are small in size, and produce not more tha twenty to forty pounds of iron in a day, with the labor of three men, and with a great waste of ore and of charcoal. The rich nati coarsely pulverized, or the grains of iron ore obtained by washi sands of certain districts, are heated with charcoal in small furnace they are reduced and yield masses of malleable metal. Somewhat methods of making malleable iron have long been known in variou tries of Europe, where, under improved forms, they are still followe have thence been brought to America. Of these furnaces for the conversion of ores into malleable iron, the five known in Europe Corsican and Catalan forges, the German bloomary forge, the C furnace, and the German Stückofen or high-bloomary furnace, which had high walls, and approached in form to the modern blast-furn which it seems to have been the immediate precursor. For a d description of these various furnaces, and the mode of working the reader is referred to Dr. Percy's learned work on the metallurgy and steel. Inasmuch, however, as furnaces related to the German bl are still largely used on this continent, and promise to become of co able importance to Canada, it will be well to describe briefly some in the history of these various European furnaces.

Iron by direct processes.

Furnaces.

Catalan forge.

Of these, the best known is the Catalan furnace or forge, so from the province of Catalonia, in Spain, where it was formerly much as well as in the neighboring parts of France. The department of A in 1840, had in operation forty-nine of these furnaces, producing tons of metal, of which 215 tons were a crude kind of steel, the rem being malleable iron. The process has there, however, since pr fallen into disuse. Similar forges continue to be employed on the coast, and, in 1850, there were forty of them in operation in the pr of Genoa, where they were used for the treatment of specular ir brought from the island of Elba. In the French Pyrenees, ho (department of Ariège) the ore generally used in these furnace hydrous brown oxyd, holding from forty to fifty per cent. of iro approaching in its character to the bog ores of the province of Queb

The Catalan forge consists of a rectangular hearth, constructed

y iron plates, which, in the largest size, is about forty by thirty-hes, and from twenty-four to twenty-seven inches deep, or from to fifteen inches below the twyer. In some districts, however, of not more than one-half these dimensions are built. The pres- the blast employed does not exceed 1½ or 1¾ inches of mercury, twyer is directed downwards, at an angle of thirty or forty . The wall facing the twyer, slopes outward towards the top, and in , the greater part of the charge of ore is heaped against it, upies from one-third to one-half of the cavity of the furnace, the ng space being filled with ignited charcoal. The ore is previously so that the large lumps are not more than two inches in diameter, om one-third to one-half of the material will pass through a screen, of which are four-tenths of an inch apart. This finer ore is on the surface of the fire, from time to time, during the operation, s conducted with many precautions as to regulating the blast, supplying the fine ore and coal. At the end of six hours, in the routine, there is withdrawn from the bottom of the furnace an rated mass of reduced but unmelted iron, which is then forged oms or bars. The operation, lasting six hours, consumes, in one arger sized forges, about 9½ cwt. of ore and 10½ cwt. of charcoal, ds 3 cwt. of bar iron. According to another calculation, there are for the production of 100 pounds of iron, 340 pounds of charcoal pounds of an ore containing from 45 to 48 per cent. of iron. Of ut seven-tenths are obtained in the metallic state, the remaining nths passing into the slag. 100 pounds of ore yield 31 pounds ron, and 41 pounds of slags, which are dark-colored basic silicates, h in oxyd of iron. Mode of working.

Corsican forge is a more primitive form of furnace than the Catalan, hout interest, except so far as it belongs to the history of iron- . It is said to have consumed more than 800 pounds of charcoal production of 100 pounds of iron. Some few of these forges were peration in Corsica forty years since. Corsican forge.

ner form of furnace, described by Dr. Percy under the name of the furnace, was used during the last century in Norway and Sweden. a rude hearth, with walls around it, and an opening in one of the r the tap-hole, which was built up with stones, and taken down was required to extract the loup or mass of reduced iron. This was not capable of yielding more than 1½ tons of iron in a week, still used in Finland, and it is mentioned as a curious fact, that bog ores which contain so much phosphorus as to yield but a poor -short iron by treatment in the blast-furnace, and subsequent decar- , afford a good malleable iron when reduced by the direct method, Osmund furnace.

in the Osmund furnace ; a result which appears to be due to t the phosphorus, which is reduced and passes into the iron, i furnace, escapes reduction at the lower temperature of t furnace.

Improved Catalan, or Geneose forge.

An improvement in the Catalan forge has been introduced in of Genoa, in northern Italy, and consists in the utilization of the which is made to roast, and subsequently partially to reduce, th treating it in the forge. For this purpose a flat-bedded re furnace, so constructed as to receive, at one end, the flame fro was provided at the other end with a charging-door, within which was a vertical chamber, communicating with the chimney, a side-door, and a grating at the bottom. Upon this grating specular oxyd containing 68 per cent of iron, was laid, and exp heat, which roasted it, expelling a small portion of sulphur. thus heated for some time, it was withdrawn and thrown int which process it was rendered friable. Being then broken into s and coarse powder, it was spread out evenly on a layer of broke with which the bottom of the reverberatory hearth had prev covered, and was here exposed to the heating effect of the from the forge, during the whole time of working a charge in In this operation the bed of charcoal was consumed, and the or twelve per cent. of its weight, being partially deoxydized. S of cast iron or wrought iron were then added to the half-re and the whole mass, by means of a rabble introduced through th door, was pushed forward into the forge-hearth. In this way, instead of four, could be worked off in twenty-four hours, economy in charcoal, improvement in the quality of iron, and a greater yield. Separate furnaces were also constructed in with these works, for reheating the iron to be drawn out into b the waste heat from these was also employed in heating reverbe above explained.

Working results

One of the Catalan forges, with these improvements, yields of six days, thirty heats of iron, with an average consumptio heat, of 95.30 kilogrammes of ore in lumps, 63.50 of ore in pow of wrought-iron scrap, and 254.00 of charcoal, with a yield kilogrammes of bar iron. This is equal to 1575 pounds of iron four hours, with a consumption of 2794 pounds of charcoal. ever, to be noticed that about 22 per cent. of this product, or 3 was added in the condition of wrought-iron scrap, whose rework consume comparatively little charcoal. Making a liberal allowan we may fairly consider the work of the furnace as nearly eq production, from the ore, of 1400 pounds of iron, which is at the

ron for 100 pounds of charcoal consumed, and is about the
ned with the American bloomaries, to be noticed farther on;
roportion obtained with the unimproved Catalan forge, des-
e, is only at the rate of 30 pounds of iron to 100 pounds of

has already been made of the German high-bloomary furnace,
n, which is of no particular interest in this connection, and is
nfounded with another furnace known simply as the German
This was formerly used in Silesia and the Palatinate, and is
t some length in the classic work of Karsten, written a little
alf a century since (1816), but is dismissed with a few words
erl's treatise on metallurgy, published in 1864 (*Huttenkunde*,
om which its use would seem to be nearly or quite abandoned
. According to Karsten the German bloomary consisted of an
a box of iron plates, in either case lined with refractory bricks,
an internal diameter of from fourteen to twenty-one inches,
me depth, the dimensions varying with the fusibility of the
rce of the blast and the quality of the coal. The twyer
al; the furnace having been filled and heaped up with burning
e ore was thrown upon the fire by shovels-full at a time; this
continued, the supply of fuel being renewed, until a loup of
ze had been formed at the bottom of the hearth, as already
the Catalan method. When the blast is too intense, or the
nse, it may happen that the reduced iron becomes carburetted
xtent as to produce steel-like iron, or even molten cast-iron,
loup of soft malleable iron. A similar state of things some-
s in the Catalan forge, and is occasionally taken advantage of
imperfect kind of steel.

German bloomary.

above description it will be seen that the method by the
omary differs from that by the Catalan forge, in the fact that,
, the greater part of the charge of ore is placed, at the com-
of the operation, in a coarsely broken state, on the sloping
furnace, opposite to the twyer, while the remaining portion is
y projected, in a more finely divided condition, upon the surface
In the German method, on the contrary, the whole of the
ed to this finer condition, and is added by small portions, a plan
nses with the charging of the furnace after each operation, as
lan method, and permits of a continuous working, interrupted
withdrawing of the loups from time to time. The German
n an improved form, is extensively used for the reduction of iron
United States, where it is known by the name of the bloomary
rsey forge, or the Champlain forge, and is also frequently called

Distinguished from Catalan.

the Catalan forge, from which, as has already been shewn, it is d form, and still more distinct in the manner in which it is worked. proceeding to describe in detail the American bloomary fire, it wil to notice some of the advantages of the direct methods of extrac from its ores, and to point out the conditions under which they used with advantage.

Direct processes

Karsten remarks that the iron obtained by a direct process is superior quality, for the reason that the separation of the foreign of the ore is effected by a kind of liquation, rather than by complet and, moreover, that certain impurities, which would be reduced with the iron at higher temperatures, are carried off by the sla unreduced state, at the lower heat of the open forge. A strik tration of that has been given above, in speaking of the Osmund and its use in Finland. For these reasons Karsten was of the opi in some regions, and with certain ores, the direct process was, more advantageous than the use of the blast-furnace combined finery-hearth. This, however, was half a century since, and meantime, great improvements have been made in the manufactu iron, as well as in puddling or otherwise treating the pig-metal. of all these facts, and of the great facilities for transportation at th day, Dr. Percy observes (in 1864), " that there can only be tively few localities in Europe where these (Catalan) forge conducted with profit. In mountainous regions abounding in ores and wood suitable for charcoal, and still inaccessible to rail Catalan process may hold its ground, but certainly not in localiti it is unprotected by high rates of carriage, or other circumstan competition with iron smelted and manufactured by modern proce advantages are that the outlay and floating capital required for a inconsiderable, and the consumption of charcoal is comparatively s (Percy, *Metallurgy of Iron and Steel*, page 311.)

Bloomaries in America.

The German bloomary process was probably introduced in America early in the last century. Among the forges in ope New Jersey and Pennsylvania in 1856, Lesley, in his *Iron Manuf Guide*, mentions one as having been established in 1733, and a 1725. These were, perhaps, bloomaries for the conversion of pi the Walloon method, which was used in this region at an early d it is evident, from facts cited already, page 263, that the treatmen verized iron ores in the German bloomary fire was already pra Connecticut as early as 1761. It was, probably, the coming of immigrants which led to the use of the German rather than the forge, which, so far as I can learn, is unknown, at least, in the and eastern parts of the United States. Various improveme

om time to time, made in the construction of the furnaces, the portant of which has been the introduction of the hot blast. by supplies of rich ores, and protected, to a certain extent, from competition, by duties on imported iron, the manufacture of iron by thod has been widely extended over the United States, and has considerable importance. In the districts where it was first ed, including northern New Jersey and the adjacent portions of rk and Pennsylvania, the bloomary process is falling into disuse, ood has become scarce, and extensive workings of coal in the , with the great facilities for transportation, have rendered it more le to treat the ores in the blast-furnace than in the bloomary fire. hern New York, on the contrary, the use of the direct process to have considerably extended during the past few years. Bloomaries in United States.

works for producing iron directly from the ores, by the present are known in the United States as forges or bloomaries, and es consist of twenty forge-fires or furnaces, but in many cases of re than two or three. According to the report prepared by Mr. E. Smith, for the *Iron Manufacturer's Guide* (page 760), and d by authority of the American Iron Association, there were, in r 1856, produced directly from the ore, 28,633 tons of malleable m 203 forge-fires. Of these, 42 were in New York, 48 in New 36 in North Carolina, 14 in Alabama, and 50 in Tennessee. were besides, at that time, 35 abandoned fires, of which not less were in New Jersey. The average production from each forge- thus 141 tons. Since that time I have no means of knowing the n of this manufacture in the south and west. In New Jersey, for already given, the direct method is almost abandoned, while in n New York, on the contrary, it has greatly increased. Instead of fires reported in 1856, there were, in 1867, according to the Iron el Association Bulletin, 136 fires in activity in Essex and Clinton s, the principal seats of this industry. The aggregate product of rges was supposed by a competent authority, in 1868, to be nearly tons of malleable iron, a large portion of which is consumed at rg for the manufacture of steel by cementation, a process for which n is eminently fitted, and for which that reduced from the ore of mer ore-bed, near Keeseville, is especially prized. Two establish- n the neighborhood work the ore of this deposit; one, that of Messrs. , of Ausable Forks, had 21 fires, and the other, that of the Peru y, of Clintonville, 18 fires, in 1868. New York forges.

direct method of reduction cannot be applied to poor ores, which, d good results in the German or Catalan forge, should not contain ess than 50 per cent. of iron, while much richer ores are to be pre-

ferred. Some of the iron ores of North America consist of an aggr of crystalline grains of magnetic oxyd, mingled with so large a prop of calcareous or silicious matter as render them unfit for the bloomar without purification. This is generally effected by crushing and ing, after a previous partial calcination, and leaves the ore in a co granular state, which would not be adapted to the Catalan, althoug suited to the German or American method. This condition of thi

Palmer ore-bed. illustrated by the ore of the famous Palmer bed, just mentioned. informed at the works of Messrs. Rogers, that from four to five tons average crude ore were required to make a ton of blooms. The o raised from the mine, is chiefly magnetite, with grains of white quartz, a some portions, of flesh-red feldspar. It is slightly roasted, to render i ble, then stamped and passed through screens with openings of abou eighth of an inch, and purified by washing. Two tons of the washed ore required to make a ton of blooms. I took what seemed an average ple of the crushed ore from the stamps, and having further reduced that it would pass through the meshes of a sieve having sixteen ho the linear inch, carefully separated the magnetic from the non-mag part, which contained a proportion of grains of specular iron ore, bu chiefly quartz. The magnetic portion equalled 45 per cent. of the w A sample of the dressed ore, such as supplied to the bloomaries, treated in the same manner, by further crushing, and separation by the net, and contained 64 per cent. of magnetic ore; the non-magnetic po besides silicious matters, holding a considerable proportion of grai specular iron, which would probably raise the amount of oxyd of in this sample of the water-dressed ore to about 85 per cent., or a little 60 per cent. of metallic iron. In other districts of northern New Yo in the vicinity of Port Henry, the crude ores are richer than those mentioned, and often contain very little extraneous matter, so tha operation of washing may sometimes be dispensed with. At the New sia forge, in Moriah, the ore, which is mingled with a little quart roasted in piles, with wood, during two or three days, then crushed treated as above described. Two tons of the crude ore yield one and a of dressed ore, which is calculated to give one ton of blooms. The w ing process removes not only the foreign matters, but a portion of fine which is lost, and may be seen accumulated in the vicinity of the was tables. The bloomers, as the iron-makers are called, object to this fine as being unfit for use, but it will be seen further on that this prejudi without foundation, and that the finer grains can be used with advant though they are now rejected, and considerable loss is thereby incurr

The magnetic ores of Lake Champlain are exported to Vermont, wh for several years, a few bloomaries have been supplied with iron ore f

west side of the lake. Three forge-fires were, in 1868, in operation Salisbury, and three at East Middlebury, Vermont, five miles from the ddlebury station on the Rutland and Burlington Railway. The ore for purpose is brought by water from Port Henry or Port Kent to Burton, and thence by rail to Middlebury station. This is brought partly umps, which are crushed and washed at the forge, and partly dressed to gh degree of purity, and ready for use. Vermont forges.

Overman is, so far as I am aware, the only writer who has given any ount of the American bloomary process. In his *Treatise on Metallurgy* th edition, 1868, page 541), will be found a description, accompanied igures. My own observation, as here given, have enabled me to verify general correctness and trustworthiness of Overman's statements regard to this subject.

he bloomary hearths or furnaces in different localities exhibit some litvariations in size and in the details of their arrangements. The size of hearth varies from twenty-seven by thirty to twenty-eight by thirty-two es, and the height, from twenty to twenty-five inches above the twyer, from eight to fourteen inches below. The sides are made of heavy -iron plate, and the bottom, although often of beaten earth or cinders, the best constructed hearths, also of iron, made hollow, and kept by a current of water, which is made to circulate through it. In the Middlebury forges this bottom-plate is four inches thick, and has in it a hollow space of two inches. The side-plates, which slope gently rds, in descending, and rest on ledges on the bottom-plate, are one a-quarter inches thick. A water-box, measuring twelve by eight inches, t into the twyer-plate, and a stream of cold water circulates through box, and through the bottom-plate, as well as around the twyer. The th of the hearth, from the twyer-plate to that opposite, is twenty-four a half inches, and the breadth from front to rear is twenty-nine inches. twyer enters twelve inches above the bottom, and is inclined downwards ich an angle that the blast would strike the middle of the hearth. The ing of the twyer has the form of the segment of a circle, and is one high by one and three-quarter inches wide. In front of the furnace, xteen inches from the bottom, is placed a flat iron hearth, eighteen es wide. The side-plate beneath it is provided with a tap-hole, through h the melted slag or cinder may be drawn off, from time to time. The plates used in the construction of these furnaces last for two years. In furnaces used at the New-Russia works in Moriah, already mentioned, ron bottom-plate is not made use of, the bed consisting of beaten-down h or ashes. These furnaces have a depth of twenty-four inches, and sure twenty by thirty-two inches at the top, but are somewhat ler towards the bottom ; the twyer, in these, enters one of the narrower Bloomary hearths.

sides of the rectangle. While these are somewhat smaller than the for at East Middlebury, those lately constructed at Moisie are somewhat larg measuring thirty by thirty-two inches, the bottom-plate being fourteen inc below the twyer, which is placed nearly horizontal, but of the same size that described above.

The blast employed in the American bloomaries has a pressure of fr $1\frac{1}{2}$ to $1\frac{3}{4}$ pounds, and is heated by passing through a series of cast-i tubes, placed in an upper chamber, above the furnace. These are in form of inverted siphons, each limb being about seven feet in leng their exterior diameter seven, and their interior diameter five inches. the East Middlebury forges the air is made to pass successively thro three such tubes, heated to dull redness, and attains a temperature esti ted at from 550° to 600° Fahrenheit. The use of the hot blast hast the operation, and enables the workmen to produce a larger quantity of i in a given time, than with the cold blast, while, at the same time, it effect considerable saving in fuel. It is said that where 240 bushels of charc will produce a ton of iron with the hot blast, 300 bushels of the same c would be consumed if the cold blast were used. The quality of the me is supposed to be deteriorated if too hot a blast is used. With judici management, however, the use of the hot blast offers great advantages o the cold blast, and has been very generally adopted in the Ameri bloomaries.

Working of bloomaries.

The working of these furnaces is conducted in the following manner: T fire being kept active, and the furnace heaped with coal, the coarsely p verized ore is scattered, at short intervals, upon the top of the burning fu and in its passage downwards is reduced to the metallic state, but reac the bottom without being melted, and there accumulates, the grains agg merating into an irregular mass or loup, as it is termed, while the earthy m ters form a liquid slag or cinder, which lies around and above it, and drawn off from time to time through the openings in the front plate. the end of two or three hours, or when a sufficiently large loup is form this is lifted by means of a bar, from the bottom, brought before the tw for a few minutes, to give it a greater heat, and then carried to the hamm where it is wrought into a bloom ; the bloomary fire itself being genera used for re-heating. This operation concluded, the addition of ore to t fire is resumed, and the production of iron is thus kept up, with but lit interruption. In this way, a skilled workman will, with a large sized f nace, bring out a loup of 300 pounds every three hours, thus making t produce of the day of twenty-four hours, 2,400 pounds of blooms ; in so cases, it is said, 1,500 pounds, and even more, are produced by twelve ho working.

In this connection may be mentioned an arrangement, described a

ired by Overman, in which the waste heat from the forge, (or rather from forges united,) passes into an oven or stove, placed at a level above the mary-fire, and there serves to re-heat the blooms, when it is required to w them out into bars. A set of small blast-pipes, placed just above the e, serves to heat a portion of air, which is led into the oven, and e burns any escaping carbonic oxyd gas. The air and gases from re-heating oven are afterwards employed to heat the blast for the mary hearth, in the usual manner. I have not seen this arrangement peration. Waste heat.

he following observations will serve to give some notions of the working he bloomary process in the United States. At the Ausable works, as ady stated, the somewhat lean ores are dressed so as to yield about fifty cent. of iron, two tons of ore being required for one ton of blooms, e at the New Russia forges, in Moriah, near Port Henry, where a ly pure magnetite is employed, three tons of the dressed ore are stated ield two tons of blooms. When it is considered that perfectly pure netite contains only 72.0 per cent. of iron, this proportion of 66.6 per ., said to be obtained, shows a great economy in working. These es, furnished me by the proprietor of the forges, Mr. Putnam, were wards confirmed by Mr. Pearson, the director of those at East Midury, where the very rich ores from the same region are treated. The nsions and construction of the New Russia forges have already been a. The pressure of blast employed was from $1\frac{1}{2}$ to $1\frac{3}{4}$ pounds, and average produce of iron for each fire, 2,400 pounds of bloom-iron in ty-four hours; the amount of charcoal consumed being from 250 to bushels to the ton of blooms produced, and the weight of the charcoal sixteen to eighteen pounds to the bushel. New Russia forges.

t East Middlebury, where, as just stated, the conditions are very ar, the estimated consumption of charcoal was 270 bushels to the ton ooms, a result which is the mean of the figures obtained at the New ia forges. Some of the ores here used contain a little phosphate of and it was observed that when too hot a blast was used, although the iction of metal was rapid, the iron from these ores was hot-short, with the cold blast, formerly employed, the iron, although produced slowly, was never hot-short. The force of the blast at these forges qual to one and three-quarter pounds, and even two pounds to the Mr. Pearson, the director of the East Middlebury forges, made, in utumn of 1867, experiments on several tons of the iron sands from a Islands, page 266, and succeeded in obtaining from them about threehs of their weight of good iron. He, however, found it necessary, in to treat these fine sands, to reduce very much the force of the blast, perience which has been confirmed by the practice at Moisie. It East Middlebury forges.

appears to be from ignorance of this fact, that the bloomers of New Y had always rejected the fine sandy ore separated during the process washing, as being unsuited for treatment in the bloomary fire.

Moisie forges.

At Moisie, although eight forges have been constructed, but four of th were in operation at the time of my visit in August, 1868, and the sa number, I am informed, in October last, two of the furnaces not hav yet been completed. A reverberatory furnace has, since my visit, b constructed, in which it is proposed to re-heat the loups for the second ha mering, instead of returning them, as in most cases is done, to the forge- for that purpose. The opening of the twyers used measured one inch one and seven-eighths; they were inclined downwards at a very sm angle, it having been found by experience that the considerable inclinat which is used with the coarser ores cannot be advantageously emplo with the fine sands. In like manner, as remarked above, it has b necessary to reduce the force of the blast, to from $\frac{7}{8}$ to $1\frac{1}{4}$ pounds, average working-pressure being about one pound to the inch. Accord to the latest accounts, there were, in October, four hearths in regular ope tion, requiring four bloomers, one assistant to furnish coal, etc., and hammerer, being six men in all for each shift of twelve hours. E hearth furnished eight loups daily, and the aggregate yield of iron estimated at three tons, or three-quarters of a ton for each hearth, ev twenty-four hours. The consumption of charcoal was 1400 bushels da being at the rate of 466 bushels to the ton of blooms, or 350 bushels each fire. This charcoal is chiefly produced from spruce and fir, with so admixture of birch, the wood being mostly small, and the weight of

Consumption of charcoal.

coal is stated to be fifteen pounds to the bushel. This gives a consumpt of 6990 pounds of charcoal for the production of 2240 pounds of bloo being at the rate of 3.12 pounds of charcoal for the pound of iron. we compare this result with the figures given above, for those for which treat nearly pure magnetic iron ores, we find that to produce a to blooms there are consumed, at East Middlebury, 270 bushels, and at N Russia from 250 to 300 bushels of charcoal, weighing from sixteen eighteen pounds to the bushel. If we assume, in both cases, the grea weight, of eighteen pounds to the bushel, we have for 250 bushels, 45 pounds, and for 300 bushels, 5400 pounds of charcoal, the former cor ponding to 2.01 pounds, and the latter to 2.41 pounds of charcoal to pound of iron, or, taking the mean of the two, 2.21 pounds, as compa with the 3.12 pounds said to be consumed at the Moisie works.

Sizes of hearths.

If now, we consider the relative sizes of the different bloomary heart we find them to be as follows:—

New Russia.............	20 × 32	inches	= 6,400	square	inches.
East Middlebury..........	24 × 29	,,	= 6,960	,,	,,
Moisie..................	30 × 32	,,	= 9,600	,,	,,

The area of the Moisie hearths is, then, in round numbers, one and a-half nes that of the others, and, with an equally powerful blast, they should nsume one-half more charcoal. This increased size is, however, counter-lanced by the feebler blast, and we find that each fire at Moisie con-mes, in twenty-four hours, 350 bushels of charcoal, equal to 5250 unds, which, from the calculations already given for the New Russia ges, should produce, with an ore such as there treated, 2375 pounds iron. In fact, the Moisie forges, according to the data before us, with area one-half greater, consume daily the same weight of charcoal as ose of New Russia, and produce only two-thirds as much iron.

I have very recently been informed that, with careful management, it s lately been found possible so far to reduce the consumption of fuel Moisie, that a ton of blooms can be made with 350 bushels of properly epared charcoal. The consumption of ore, which formerly amounted to ee tons or more for a ton of blooms, is also said to have been considerably luced, the daily production of iron from each hearth, however, remaining same as before.

The cause of this small production of iron, as compared with the area the furnace, and with the consumption of fuel, is not, in my opinion, to found either in the reduced force of the blast or in the mechanical ndition of the ore. A great heat is not required for the reduction of the yd of iron to the metallic state, and other things be equal, the finer its odivision, provided it be not dissipated by the blast, the more rapid and re complete should be its conversion to the condition of metal, by the ion of the reducing gases, as it passes downward through the mass of rning charcoal. Such coarse grains of ore as pass, incompletely reduced, ough the ignited fuel, and in this state reach the slag below, have no ance of further reduction in the forge. Hence we may conclude that, fineness of the ore, should, under favorable conditions, render the luction more complete. Causes of the smaller yield.

The principal cause of the small yield of the Moisie furnaces is appa-ntly to be found in the incompletely purified condition of the ore. It will seen in the detailed analyses on page 267, that the iron sand, as now epared for the forge, may, by the use of the magnet, be divided into two arly equal portions. One of these is magnetic, and consists, for the eater part, of magnetic oxyd ; it contains over two-thirds its weight of n, and is nearly equal in richness to the magnetic ore used in the New ssia forges. The other half is a highly titaniferous oxyd, mixed with re or less silicious matter, and containing only 44 per cent of iron ; and admixture with the magnetic oxyd, which reduces the proportion of iron the whole to 55 per cent, appears to be not merely useless, but actually ejudicial. Nature of ore.

When an impure ore of iron is treated in the blast-furnace, cert substances, called fluxes, are added, which form fusible combinations w impurities. Thus, if the ore contains silica, a sufficient quantity of li is smelted with it, and a silicate of lime is formed, while the oxyd of ir being left free, is wholly reduced to the metallic state. In the dir method, on the contrary, no fluxes are used, and if silica be present in ore, it combines with a portion of the oxyd of iron, forming a silicate

Nature of slags.

iron, which melts into a slag or cinder, from which the iron cannot be se rated in the forge. Thirty parts of silica will, in this way, unite w seventy-two parts of protoxyd of iron, equal to fifty-six parts of meta iron. In the case of the somewhat silicious ores of the Pyrenees, trea in the Catalan forge, we have seen that three-tenths of the iron pres in the ore pass into the slag, and the loss would be much greater did these ores hold a considerable proportion of manganese, lime and otl bases, which help to satisfy the affinity of the silica, and to leave the i

Silicious impurities.

free. Such substances as these, play the part of fluxes with a silicious o but if they are wanting, a portion of the oxyd of iron itself is consum for the purpose, forming, in fact, the only flux for the silicious im rities, when such an ore is treated by the direct method in the blooma fire. Whenever, in the Catalan forge, the American bloomary fire, any other direct method, we have to treat an ore containing free sili provided other bases are not present, we must always allow oxyd of ir in the proportion already indicated, for the saturation of the silica, being the rate of nearly two parts of metallic iron for each part of silica pres in the ore. It is for this reason, it may be remarked, that kiln-burn charcoal is to be preferred, for the bloomary hearth, to charcoal made piles; the latter being generally more or less impure from adhering silici earth, which, by combining with oxyd of iron, causes a waste of the o

The quartzose sand which is mixed with the iron sands, is nearly pu silica, and the oxyd of titanium which they contain, appears, from t analyses of slags given below, to require, for fluxing it, as much oxyd of ir as the silica itself. These slags, in case no other bases than oxyd of ir are present, should approach very closely to the composition of a tribas silicate of protoxyd of iron, which, as already explained, contains 30 silica to 72 of protoxyd of iron, or 29.40 per cent. of silica, and 70. of protoxyd, equal to 54.9 per cent. of metallic iron. The highly tita ferous slags produced at the Moisie furnaces, contain, in some cases, still large proportion of oxyd of iron.

Of the following analyses, I is of a crystalline, black, brilliant magnet slag, which contained cavities lined with large pyramidal crystals, apparent dimetric in form. It was produced at the Moisie forges in the autumn of 1867. II was a portion of the ordinary slag produced at the time

visit, in August, 1868, and was similar to the last, but somewhat Moisie slags.
icular, the cavities being lined with very small brilliant crystals. Both these slags readily gelatinized when treated, in powder, with hydro- oric acid. The residual silica, however, showed a portion of grains undecomposed ore, which was larger in the second specimen; it was, each case, deducted from the analysis. The whole of iron in both hese slags is represented as protoxyd, and the results are compared 1 those of two analyses of the non-magnetic portion of the ore, copied n pages 267 and 268, and here given under III and IV.

	I.	II.	III.	IV.
Protoxyd of iron	67.14	52.31	58.20	56.38
Oxyd of manganese	undet.	2.04	.....	1.10
Lime	1.37	.....	.....	.95
Magnesia	.80	.18	.....	....
Alumina	. ..	.56	....	....
Titanic acid	20.07	34.05	30.74	28.95
Silica	8.75	11.29	6.14	8.75
	98.13	100.42	......	......
Metallic iron	52.22	40.68	45.26	43.85

From a comparison of the above analyses it will be seen that the first slag tains more oxyd of iron than the non-magnetic portion of the ore; which, he conditions of working, at the time the slag was produced, actually olved and carried away a considerable portion of the reducible ore. ve were to regard one half of the washed ore as composed of pure gnetic oxyd, this, were it wholly reduced, could only yield an amount netallic iron equal to 36 per cent; but the magnetic ore, as we have n, still retains more than 6 per cent of silica and titanic acid, which must removed by fluxing with a portion of the oxyd of iron present, giving to a certain amount of slag. Meanwhile the non-magnetic ore, in ting, removed another portion of iron oxyd, so that when this slag made, more than three tons of a mixed ore, having the composition ve given, must have been consumed for the production of a ton of oms; while, of the magnetic portion of the ore, one and a-half tons, or a y little more, would suffice. (In the production of the slag II the loss iron was somewhat less.) This explains why the Moisie furnaces e yielded, when compared with those of New York and Vermont, so all an amount of iron for the labor employed and the fuel consumed. To oduce a ton of iron it has been necessary to handle twice as much ore as required in forges where a pure ore is treated, and moreover one and alf tons, or more, of worthless material have been fused, and got rid of slag, thus involving a great waste of fuel, as well as of labor. It may e be remarked that a portion of slag taken by me from the East Middle-

bury forges, contained according, to Mr. Broome's analysis, 48.2 per c of iron (equal to 62.06 of protoxyd), and 16.70 of silica, besides 17.33 alumina, and 1.82 of oxyd of manganese. The amount of slag produced the rich ores which are treated at these forges, is comparatively very sm

It would seem probable that by a judicious management of the worki the waste of iron in the slags at Moisie, might be considerably reduc and this result, we are assured, has lately been attained; but it will s remain true, that a large amount of iron-oxyd must be consumed to flux considerable proportions of silica and titanic acid, which are present in mixed ore, even after careful washing.

Reduction in crucibles.

It should here be explained that the result would be far otherwise if t ore, with all its impurities, were to be fused in a crucible with carb aceous matters, with, or even without proper fluxes. In the former ca as in a blast-furnace, the whole of the iron which it contains, amounti to not less than 55 per cent., might, by judicious admixture, be set fr and reduced; and in the latter cases, without fluxes, it has been shown Percy, that by fusion at a high temperature, in a crucible lined w charcoal, the tribasic silicate of iron, already noticed, gives up two-thi of its iron, which is reduced to the metallic state, so that the amount unreduced oxyd retained by the slag would be inconsiderable. From t it is evident that the results of fire-assays, or trials on a small scale crucibles, cannot serve as a guide to the working of iron ores in the dire method.

A certain amount of lime added to the ore, would doubtless reduce t waste of iron in the slags, and thus allow more iron to be obtained fro the mixed ore; but although such an addition is useful in the blast-furna it would require experiments to determine whether the practice could advantageously introduced in working in the bloomary-hearth. In a regi where the ore is so abundant and so cheap as it is at Moisie, the savi of iron is a consideration which should be subordinate to the economy fuel and labor, and the most profitable way of working these iron-san would seem to be by separating and rejecting the non-magnetic portio by some apparatus like that described farther on.

Quality of iron.

The quality of the iron produced at the Moisie forges is superior. A the result of experiments made upon it in England, it is said to possess tensile strength greater than that of Low Moor iron, and to work easil both hot and cold. It is now employed at Montreal for the manufactu of railway axles.

The fact that those objectionable elements, sulphur and phosphoru occur in but very small quantities in the iron-sand of Moisie, has alread been noticed. It is probably to the absence of these that the excellenc of the Moisie iron is due. In a specimen taken from a bloom which wa

de in my presence, at the Moisie forges, the presence of sulphur could detected by delicate tests, but its amount was only .0094, or less than $\frac{1}{100}$; while the quantity of phosphorus present was equal to ·0184 cent. This iron contained no trace of titanium in its composition, a small mass of white crystalline cast iron, which had accidentably n formed in one of the forges, was equally destitute of titanium.

Cost of bloomary iron.

The cost of producing a ton of iron blooms directly from the ore, by the mary process, varies greatly with the price of the dressed ore, which depend on the proximity of the mine to the forge, and the richness of crude ore. Thus, the cost of the two tons of dressed ore employed to e the fine iron of the Ausable forges, was estimated by Mr. Rogers, in 8, at not less than \$18·00, while the one and a-half tons of ore coned at New Russia, would not probably cost more than one-half that . The following estimate made by a highly competent iron-master, 868, may serve as a guide to the cost of producing iron at that time New York:—

2 tons of ore	\$10.00
300 bushels of charcoal @ 8c.	24.00
Wages	9.00
General expenses	3.50
Cost of the ton of blooms	\$46.50

he above prices are in American currency, which, at that time, was al to about $\frac{80}{100}$, making the gold-value \$37·20. The estimate of ther manufacturer, in Clinton county, gave \$7·00 for wages. It will bserved, moreover, that the amount of charcoal, in the above estimate, eeds the average consumption for the production of a ton of blooms, ch may be taken at about 270 bushels.

Comparative cost.

o produce a ton of blooms from cast iron, in what is known in Sweden, he Lancashire hearth, there are consumed, according to an authority d by Percy, 23 cwt. of pig iron, and $\frac{9}{10}$ tons of charcoal. In New Jersey Pennsylvania the conversion of the pig iron, is, for some purposes, ted by a somewhat similar process, which involves two operations, the ing in the running-out fire, and a subsequent treatment in the ing-fire, as it is called, which is a bloomary forge very like that used the ore in the direct method. To produce a ton of blooms in this , there are consumed 24 cwt. of pig iron, and 100 bushels of charcoal, rding to one authority, while another estimate gives 120 bushels; quantity varying both with the quality of the crude metal, and the coal; while, with some arrangements, the consumption of fuel is much

greater. The mean of these, 110 bushels, at 18 pounds to the bush would give, almost exactly $\frac{9}{10}$ of a ton, the amount used in Swed The quantity of charcoal consumed for the production of a ton of pig i in the United States varies greatly, but in the best constructed and m modern furnaces, like those of Michigan, with rich ores, will not exce 130 bushels of charcoal of the above weight, which gives, for 24 cwt. pig iron, 156 bushels. (See page 256.) This, added to 110, equals 266 bush the total amount of fuel required to produce a ton of blooms by means the blast-furnace with the charcoal-finery. There would appear to be little difference, so far as the consumption of the fuel is concerned, betw the cost of producing bloom-iron by the direct and indirect methods j described. The first cost of the establishment for the former is, howev less, and this is probably one of the reasons which has led to the adopt of the direct method by the bloomary forge in northern New York.

The conversion of the oxyd of iron to the metallic state, under t influence of solid carbonaceous matter, or reducing gases, takes place a temperature considerably below that at which the affinity of silica for t oxyd of iron is exerted. Even the compound of titanic acid with ox of iron is decomposed at a red heat in contact with hydrogen gas, t iron being wholly reduced to the metallic state. If it were possible effect this reduction, and subsequently to eliminate the silica and tita acid from the metallic iron, ores containing these impurities might be ma available for the direct method of conversion ; but the practical difficult of effecting such a separation are such that the only available modes treating such ores as contain considerable amounts of these impuriti are to smelt them in the blast-furnace with proper fluxes, or to effect complete a separation of the impurities as possible, before submitting th

Purifying ores. to the process of reduction. This, in the case where heavy granular o are mixed with quartz and feldspar, as for example, at the Palmer ore-b already noticed, is attained by washing away the lighter materials. Whe however, the impurity is chiefly titaniferous iron, as in the Moisie san the separation may be readily effected by means of magnets, a proc which is equally advantageous where magnetic iron ore is mixed w lighter impurities, as quartz or silicious minerals.

The use of magnets for this purpose has long been taken advantage and various machines with permanent and with electro-magnets have be contrived. A simple and ingenious arrangement for this end, which l been invented and patented by Dr. F. A. H. Larue, of Laval Universit Quebec, appears to be novel in the mode of its working, and is ve efficient and cheap. The mixed sand or crushed ore is poured through screen, into a hopper, the discharge of which is so arranged as open and close at proper intervals of time, and, falling from this, is spre

thin and uniform layer, upon a series of aprons arranged, with spaces, between two parallel endless bands, which pass over two ontal cylinders. These aprons, charged with ore, are made, by the ement imparted to one of the cylinders, to pass from beneath the er, and under a series of permanent horse-shoe magnets, 800 in number, capable of sustaining about five pounds weight, arranged upon verse bars, in five rows of 160 magnets each. Beneath these is a an, covered with muslin, which, when the iron ore is passing beneath, is in the contact with the poles of the magnets. So soon, however, e magnetic portions of the ore have arranged themselves, by magnetic ction, in adhesion to the under side of the tympan, and the apron noved from beneath, and gone forward to discharge the non-magnetic on of the ore at the foot of the machine, the tympan is momentarily lrawn a short distance from the poles, and the adhering magnetic ore in the open space between two aprons, into a receptacle placed below. process of loading and unloading the magnets can be repeated twice in minute.

Larue's magnetic machine.

ese machines, as now constructed, occupy a space of about six feet by and are four feet high; they are said to cost, at Quebec, at about each. One, of these dimensions, will, according to Dr. Larue, treat hour, three tons of sand holding one-third of magnetic ore, separating it one ton, containing over ninety-nine per cent of magnetic grains. e myself seen only a smaller machine, the first one constructed, had a capacity of about one-half that just stated. The motive r required is very small, and the mechanism, as will be seen from the iption, exceedingly simple. Dr. Larue observes, that, inasmuch as a sand may be passed through the machine as rapidly as a poor one, the is directly proportionate to the amount of magnetite present, so that nd containing one-fourth as much as that above mentioned, would about six tons of purified sand in twenty-four hours. Even very sands may, probably, with this machine, be treated with advantage. ame process of purification may doubtless be applied with advantage, crushing, to the preparation of lean massive magnetic ores for the ary fire, or for other direct methods for conversion into iron and A process of partial reduction, at a low red heat, will render non-etic iron ores attractable by the magnet, a reaction of which Chenot ince proposed to take advantage, for the purification of such iron ores not naturally magnetic.

accordance with the well-known fact that the reduction of oxyd of akes place at a temperature very much below that required for its quent carburation and fusion, it has been shown that the charge of a blast-furnace is converted to the metallic state some time before it

Various direct processes.

descends to the zone in which melting takes place. It forms, when reduc a spongy mass, readily oxydized, which, by proper management, ca compressed and made to yield malleable iron, or by appropriate mode treatment, may be converted into steel. This fact has been the star point of a great number of plans designed to obtain malleable iron steel, without the production of cast-iron and the employment of processes of puddling and cementation. This, it is true, is attaine Catalan and bloomary forges, but the attention of many inventors been, and still is, directed to the discovery of simpler, or at leas more economical methods of obtaining similar results. A short sketc the various new processes will not be without value, as bearing upon utilization of the iron ores of Canada, and especially of its iron sands.

Chenot's method.

Of these, the method of Chenot is best known. His experiments s to have been commenced about forty years ago, since we are infor that he had erected a large furnace for the direct treatment of the ore iron, in 1831, although his results were not brought before the public u twenty years later, at the International Exhibitions of 1851 and 1855 was a member of the International Jury at the latter, and had an op tunity of studying Chenot's process as then conducted, on an indus scale, at Clichy, near Paris. A description by me of the process as t and there practised, will be found in the report of the Geological Sur for 1855–57 (page 397). Rich peroxyd ores were broken in small pie mixed with a portion of charcoal, and placed in large vertical rec gular muffles or retorts, enclosed in a gas-furnace, and heated to redn The ore, after being reduced to the state of metallic sponge, passed do wards into an air-tight cooling-chamber, which was a continuation of muffle, and when sufficiently cooled, was withdrawn. The spongy me thus obtained, was then exposed to a welding heat in a proper furnace, formed into balls, which were afterwards treated like the balls fro puddling-furnace, and gave malleable iron. By impregnating the met sponge with oily and tarry matters, and afterwards expelling these heat, a sufficient amount of carbon was fixed in the metallic spong convert it into steel. By grinding, compressing and melting this car ized sponge, cast-steel of a superior quality was manufactured at pr which, it was claimed, were much below the cost of steel prepared cementation of bar iron. This process was subsequently introduced several places in France, Belgium and Spain, where it was applied to manufacture of bar iron, and up to 1863 at least, was worked on a c siderable scale at Baracaldo, in Spain, where, in 1859, about ten ton iron were manufactured daily from iron sponge.

A very important modification of the process already described which the heating was effected externally and indirectly, consisted in

ernal or direct method of heating. In this the outer furnace and the mixture of charcoal with the ore were both dispensed with. The vertical duction-chamber was filled with ore only, which was reduced by the ion of currents of heated carbonic oxyd gas, obtained by forcing , at a pressure equal to half an inch of mercury, through two generors filled with ignited charcoal. This mode of producing the sponge s found much more economical than that by indirect or external ting. The working results of the direct method, as carried on at marade, in Spain, in 1863, are given by Percy ; from which it appears t for the production of one ton of blooms, there were consumed 1.87 s of charcoal. The greater part of the fine Swedish iron used at Sheffd for the manufacture of steel, is produced from charcoal-made pig, ated in a charcoal-finery, known as the Lancashire hearth, and is ained with a consumption of charcoal, which, for the united processes reduction and refining, amounts to 1.90 tons for the ton of blooms, a ult almost identical with that of the process of Chenot. (Percy, *Metalgy*, pp. 342–596.) The modified Catalan forge, and the American omary fire, as we have seen, produce malleable iron with a consumption harcoal which is not very much greater, and with a simpler, and probably s expensive apparatus than that required for the Chenot process ; while method by the blast-furnace permits of the use of ores which are unfit treatment by any of these direct processes.

Chenot's direct heating.

Comparative cost.

The patents granted to Clay, in England, in 1837 and 1840, were for manufacture of malleable iron by a process essentially the same with enot's earlier method of indirect or external heating. According to y, hematite ores were mixed with one-fifth of their weight of charcoal, e, or other carbonaceous matter, and heated to bright redness in a clay ort, or other suitable vessel, until the ore was converted to the metallic te. When the reduction was complete, the spongy iron (without previous ling, as in Chenot's plan,) was transferred directly to a puddlingnace, where it was brought at once to a welding heat, made into balls, then wrought into blooms in the usual manner. This process was d on a pretty large scale near Liverpool, in 1845–46, and although was regularly made by it for some time, and to the amount of 1000 s, the process was not found to be commercially profitable, and was ndoned.

Clay's method

The process of Renton, patented in the United States in 1851, was y similar in principle and mode of working to that of Clay. The mixe of ore and coal was introduced into a vertical muffle or retort, which s inclosed in the flue or chimney of a furnace, not unlike an ordinary ddling-furnace. The contents of the muffle, being sufficiently heated, re reduced to the metallic state, and, from time to time, discharged from

Renton's process.

the bottom, into the furnace, where the spongy iron was exposed t welding heat, and wrought into blooms. This process, after having b essayed on an industrial scale at Cincinnatti, and at Newark in N Jersey, was abandoned. A similar fate attended the trials, on a large sc

Harvey's process.

of Harvey's patented process, at Mott Haven, near New York, about same time. In this, the coarsely powdered ore, mixed with charcoal, placed on inclined trays or shelves of steatite, in a heated chamber c nected with a welding or balling-furnace. The flame from a fire be was made to pass through the chamber, and the ore, being at length redu to the metallic state, was transferred to the hearth below, and th converted into blooms. For a farther description of these various p cesses, and the similar plan of Yates, the reader is referred to Perc *Metallurgy*, pp. 330–348.

Gurlt's patent.

Chenot's plan of reducing the ore by a current of carbonic-oxyd g was adopted by Gurlt, who used the direct mode of heating, alrea noticed. The gases from the generators charged with fuel, were through flues, into the vertical reducing-chamber, a blast of air being at the same time introduced into the flues, in sufficient quantities to k up the combustion of the gases. By this means, according to the sp fication, "there passes into the shaft a mixture of flame and carboniz and reducing gases, by which the iron ore is heated" and carboniz According to Gurlt's patent-specification, (No. 1679, London, July 1856,) by continuing, for a sufficiently long time, the action of the gas the resulting iron sponge may be more or less carbonized, so as to yield, subsequent fusion, either cast iron or steel. These partially carboniz products he proposed to melt in a reverberatory gas-furnace, the blast air into which is to be "so regulated that it exactly burns the gas produc in the generators," and that neither unburned gases nor unconsumed escape; the object being to obtain a neutral flame, which should alter the sponge upon the hearth. In this way carbonized sponges fr rich ores, are said to have been successfully converted into cast iron Spain.

Gurlt's ingenious specification thus involves the idea of first reduci the iron ore to a metallic sponge, and afterwards carbonizing this spon so that, by subsequent fusion, it may be converted into cast iron or ste Although the conception of thus carbonizing the iron while in a spon state, is probably novel, the use of carbonaceous gases or vapors carbonizing iron, and converting it into steel, is not new, as may be se from the patent for this purpose granted to Macintosh in 1825. T experiments of Percy upon iron wire have also shewn the rapid carbonizi effect of coal-gas and heavy oily vapors, like those of paraffine; (*Metallurg* pages 109 and 773) and, according to Marguerite, carbonic-oxyd gas,

elevated temperature, yields up a portion of its carbon to iron, which is
is converted into steel. Practical difficulties have hitherto prevented
application of hydro-carbon gases and vapors to the carbonizing of bar
n on a large scale.

With the results of Chenot, Gurlt, and Macintosh before us, we are
pared to understand the process of Dr. George Hand Smith, of
chester, New York, which is just now attracting some attention in the
ited States, for the production of steel. The crushed and purified ore,
iron sand, mixed with a portion of pulverized charcoal, is heated in a
d of reverberatory furnace, with an arrangement which permits the
or of petroleum or coal-tar to pass through the mass, thus aiding in the
uction, and finally carbonizing the resulting sponge, which is then trans-
ed to a puddling-furnace, to be wrought into iron, or, if properly car-
ized, into steel.

Before proceeding farther, mention should be made of some other
thods which have been devised for the treatment of iron sands, and for
r conversion into iron or steel. In 1851 a patent was granted to
nson, for a process for working the iron sands of New Zealand, and
ilar ores from India. These were to be mixed with small portions of
y and lime, with or without the addition of charcoal; the mixture was
und in a pug-mill, with water, and formed into lumps, for subsequent
tment in the blast-furnace. In 1862, Moreau proposed to mix iron
ds with iron filings or turnings, and then incorporate them with fuel,
h as peat-coal or coke; the mixture being made into blocks, which were
e smelted in suitable furnaces. In 1866, Mr. James Hodges, who was
acquainted with the experiments of Moreau, moulded the iron sands of
sie into blocks with peat, and by treating these, after drying, in a proper
ace, succeeded in converting the ore into malleable iron, at a single
ration. (*Report of Geological Survey* for 1866, p. 291.)

Plans for working iron sands.

Messrs. Whelpley and Storer of Boston effect the reduction of the iron
ore, or pulverized ores, on the hearth of a reverberatory furnace, which
eated, in part, by pulverized coal, borne by a blast of air over the fire
olid coal upon the grate. In this way the furnace-chamber is filled
a volume of burning coal-dust, which can, by regulating the supply of
and of air, be made either oxydizing or reducing. The heated ore
the furnace-hearth is thus reduced to the metallic state, balled and
e into blooms, with, it is claimed, a great economy of fuel.

has also lately been proposed to convert these sands into steel or cast
, by melting with a sufficient admixture of charcoal in crucibles, or
r closed vessels, heated from without. This is, in fact, nothing more
an extension of the dry method for assay of iron ores. A patent for
ing steel in this way, by treating rich ores, mixed with carbonaceous

Steel direct from the ore.

matter, in air-tight melting-pots, was granted to Lucas, in 1791, an similar claim was made by David Mushet, in 1800; while, according Percy, "experiments in the direct production of cast steel from iron o in crucibles, were made by Riley, at Dowlais, a few years since, although excellent steel was occasionally produced, it was not found sible to ensure uniform results." (*Metallurgy*, p. 765.)

Ponsard's results.

More recently, Ponsard has brought forward a similar process, results of which were communicated to the French Academy of Scien July 19, 1869. This arrangement consisted of a number of fire-p crucibles, about eight inches in diameter and forty inches high, which w placed in a reverberatory gas-furnace, the mouths of the crucibles be fitted into openings in the furnace-roof, for convenience of charging. lower part of the crucible is perforated, and rests on the sole of furnace, which is furnished with gutters leading to a depression or b in the middle of the furnace-hearth. The crucibles are charged with ores, mixed with proper fluxes, and about twelve per cent. of carbon, s cient to effect the reduction and carburation of the iron, which, under influence of a very intense heat, melts, and, running through the holes the bottom of the crucible, collects in the basin in the middle of the nace. According to Ponsard, a ton of coal is consumed for each to iron produced, so that the process cannot be recommended for its econ of fuel. He, however, claims as a great merit of this process, the comp separation of the fuel from the carbon required for the reduction of ore, so that for the furnace, inferior kinds of combustibles, which, if brou directly in contact with the ore, would injure the quality of the me may be used with safety and advantage.

Johnson's patent.

The process patented by Johnson, Jan. 22, 1868, as described in *Practical Mechanics' Journal* for June, 1869, (quoted by Osborn in *Metallurgy of Iron and Steel*, page 868) is, however, exactly similar all its details, to that of Ponsard, which was first announced as a novelt the French Academy, July 19, 1869, eighteen months later. In a specif tion dated at Quebec, July 16, 1869, Dr. Larue claimed, and subseque received letters-patent for Canada, for a process similar in design to of Johnson, of which he was ignorant. Although there were differen in detail, the avowed object in both plans was to separate the ore, with carbon required for its reduction, from the fuel, (which might, co quently, be of an inferior quality,) and to permit of a continuous charg and discharging of the crucible. The difficulty of constructing sufficie refractory crucibles for the intense temperature, and the small yield to expected from such a process, would perhaps prevent it from ever be used for the manufacture of cast iron. Dr. Larue, however, anticipa its application to the production, not of cast-iron, but of cast-steel, wh

Larue's patent.

uld require a very nice adjustment of the proportions of carbon to ;ure a uniform quality in the product; as in the ancient processes of cas and Mushet, and the more recent experiments of Riley, mentioned by rcy, and referred to above.

Two processes for the production of steel are those which depend, spectively, on the combination of cast iron in proper proportions with lleable iron or iron sponge, and with oxyds of iron. In the specification a patent granted in 1839, Heath claimed the production of steel by lting with cast-iron, either wrought iron, or oxyds of iron or manganese. a second patent, granted to him in 1845, he described an arrangement which the cast-iron was kept in a molten condition, in a gas-furnace, ile pure iron in scraps, or in sponge, obtained by reducing oxyd iron, as in Chenot's and Clay's method, was added from time to time; il, by trial, the proper quality of metal had been obtained, after which liquid steel was run into ingots. Other processes, based on the reactions bodied in Heath's first patent, are those of Uchatius, (patented in 1855,) o melts granulated cast iron in crucibles, with a certain proportion of e oxyd of iron, and thus obtains a fine quality of steel, (a process eady specified in Wood's patent, in 1761); and that of Brown, (patented 1856) who, to produce steel, melts, in crucibles, mixtures of pig iron clipped bar iron. This method is practised to some extent in Sweden, ere it is known as the Obersteiner process.

Cast steel.

Heath's patents.

n the process of Obuchow, which appears to be successfully used in ssia, fine pig-iron is melted, and run into a large crucible, previously ted to whiteness, and holding magnetic iron ore, alone, or with titanic sand and iron and steel scraps. The crucible is then heated till the tents are perfectly fluid, some nitre and arsenious acid are added, and steel run into ingots. By a somewhat similar process to this, Ellers-sen attempted to produce steel, by pouring molten cast-iron upon iously oxydized sheet-iron, heated to redness, and placed in a heated el. The oxyd dissolved in the molten iron with violent chemical on, decarbonizing it, and producing a kind of steel; but it would pro-y be difficult to effect a thorough conversion of the iron without keeping he heat from without; which was not done in Mr. Ellershausen's first eriments, made in Montreal, in the spring of 1868.

Obuchow's method.

Ellershausen's plan.

he above processes, however, involve the use of crucibles, and it had me a great desideratum to produce cast steel upon the open th. This was the aim of Heath, in his process described above; but difficulties in producing and controlling a heat sufficient for the purpose, e so great as to render the efforts in this direction but partially success- until the regenerative gas-furnace of Siemens placed in the hands of allurgists the means of fusing large bodies of steel on the hearth of a

V

Martin's steel process.

reverberatory. Provided with this, the Messrs. Martin, of Sire France, have succeeded in producing cast steel, in charges of thre four tons at a time, by melting down wrought iron in a bath of cast by what is now known as the Siemens-Martin process. The product obtained, attracted much attention at the Paris Exhibition, in 1867 the process has since been widely adopted in Europe and in the U States; where it was first introduced by Messrs. Cooper, Hewitt & and is now in successful operation at their works at Trenton, New Je

Its operation.

Beginning with a bath of six hundred weight of pig iron on the he malleable iron, as puddle-bars, for instance, is added, previously heat whiteness, and rapidly dissolves in the molten cast iron, until, at th of about four hours, the charge amounts to three tons, and will be to consist of a soft, nearly decarbonized metal. It is then recarbo by the addition of from five to eight per cent. of spiegeleisen (m nesian cast iron), as in the Bessemer process, and run in moulds. bath of molten metal, during the process, is protected by a coveri fused slag or cinder.

The furnace-bottom for this process is made up of a silicious sand, w must not be quite pure, but contain some alumina or other bases, so under the influence of the high temperature, it may harden, without me forming an impervious crust, which will resist, for a considerable time action of the molten steel. The upper part of the furnace is bu Dinas fire-brick. Attempts have been made to use an admixture of of iron with the pig metal, in this process ; but it is found that the sive action of the oxyd, at a high temperature, upon the furnace-b such as to preclude its employment. The entire cost of a furnace w capacity of producing three tons of cast steel, with gas-producers, rators, and all the apparatus for moving the ingot-moulds, is, in Eng about £500 sterling.

Bessemer's process.

This process, it is true, cannot compete with the Bessemer or pneu method for the cheap production of cast steel in large quantities ; but the latter is applicable only to certain fine kinds of cast iron, compara free from phosphorus and sulphur, the process in the open h permits the employment of other qualities of iron. These, in reduced, by puddling or otherwise, to the condition of malleable iron deprived of the impurities prejudicial to steel, before being added t iron bath. While, therefore, the Bessemer process will probably re without a rival for the treatment of the purer cast-irons, the producti steel by the open hearth will perhaps become even more impor because of wider application.

Heaton process.

The Heaton process, for which so much claimed as a method for the production of steel from impure cast iro the action of nitrate of soda, appears, from the late careful studi

mer, destined to become subsidiary to the production of steel in the n furnace. Gruner concludes that it "can never, from any point of v, become a substitute for the Bessemer and Martin processes. These luce ingots of steel, or homogeneous iron, from pure brands. The ton process deals with impure brands, and seeks to convert them into fined metal, more or less purified, the treatment of which has to be shed in a Siemens furnace." He further declares that the only antageous way of treating the products of the action of nitrate of soda ast iron, is to submit them to the Siemens-Martin process. (*Annales Mines* for 1869, fifth part.)

Ir. Bessemer has very recently made experiments upon the working of process, under pressure, by which he obtains such an elevation of temture, as, it is expected, will enable him to introduce malleable iron into converters, and thus effect in them what Martin does upon the open th. In the mean time Siemens has, by the aid of his furnace, been to carry out a part of the original plan of Heath, who, in 1845, osed to reduce iron ores, by heating them, in small fragments, with coal, in a close vessel, as in the methods of Chenot and Clay, and to the resulting spongy iron to the bath of molten cast iron. The reducis, by Siemens, effected by a plan which combines the indirect and t methods of Chenot.

Siemens's direct process.

bove the furnace, and immediately over the bath of molten cast iron, h occupies the hearth, are two large tubes of refractory clay, enclosed outer casing, through which the flame from the furnace passes, and s these tubes, or reduction-chambers, to be heated, with their contents, dness. They are charged from the top with finely broken rich ore, gh which a current of previously washed and purified carbonic oxyd from the common gas-generator of the furnace, is forced, and reduces ignited ore to the condition of a metallic sponge of pure iron; this, nding, is at once dissolved in the molten cast-iron bath, and effects its ersion to steel, precisely as in Martin's plan, where solid malleable is made use of. In certain cases, as with very finely divided ores, the ction is effected by an admixture of about ten per cent. of charcoal, her carbonaceous matter.

emens has already manufactured excellent cast steel by this method, here is no doubt that, in the case where pure oxyds, free from sulphur phosphorus, can be obtained, the mode of directly producing steel spongy iron may be advantageously employed.

simple and ingenious process, based, like that of Siemens, on the nal suggestion of Heath, has recently been devised and patented by Robert G. Leckie of Montreal. Having found that when finelyed iron ore, as magnetic iron-sand, was made into lumps with peat,

Leckie's patent

coal, or other carbonaceous matter, not in excess, and exposed to redn out of a current of air, there results a nearly pure spongy metallic i he proposes to obtain iron in this way, and add it to the bath of mo cast iron, in a reverberatory gas-furnace. The ore, agglomerated with reducing material, is to be placed in one or more large chambers or ov in the rear of the hearth, and, when sufficiently heated to effect its re tion, is to be added to the bath of molten iron. He expects soon to t on a working scale, this mode of making cast steel in the open hearth which the purified magnetic iron sands of Canada, from their free from sulphur and phosphorus, would seem to be peculiarly well adap

It is one of the great advantages of the Siemens furnace, that l judicious regulation of the supply of air, and by proportioning it to gaseous fuel, it is possible to obtain, at will, either an oxydising, a reduc or a neutral flame; a point of much importance in the fusion of metal the open hearth, which was already indicated in Gurlt's specificat as explained on page 46.

Siemens's regenerative furnace.

The employment of gaseous combusibles has been greatly exten since the successful use of the regenerative principle by Siemens. T consists in allowing the heated gases, after combustion in the furn chamber, to pass out, downwards, through two chambers packed with f bricks, so arranged as to allow a free passage of air between them which they impart their heat; the waste gases passing off into stack at a temperature seldom above 300° Fahrenheit. After an inte of from half-an-hour to an hour, the current is changed, and the gases led off through another pair of regenerators; while those which had b heated by the escaping gases are now used to conduct the air and for keeping up the combustion; these passing in through the hea regenerators, have their temperature greatly raised before entering combustion-chamber. By alternately making each pair of regenera the channels for the passage of the gases to be burned, and for waste products of combustion, a very intense temperature is maintaine the chamber, with very little loss of heat.

Burning wet fuel.

Coal and dry wood have generally been used in the gas-generat where, by a partial combustion, the solid fuel is converted into c bustible gases. With wet fuel, a large amount of steam becomes ming with the gases, where its presence is very objectionable. This diffic has, however, been entirely obviated by a system lately devised in Swed which may become of great advantage to Canada. I have therefore thou it best to copy from Mr. Abram Hewitt's Report on the Productio Iron and Steel at the Paris Exhibition of 1867, the following acco of this valuable invention. This report, published by the United-Sta Government, contains excellent drawings of the furnace:

"The furnace devised by F. Lundin, of Carlstadt and Munkfors, is signed for the consumption of turf and peat, without drying, and of wet w-dust or other moist fuel; an invention deemed so valuable that the sociation of Swedish iron-masters have rewarded Lundin by a gift of 0,000, which, in Sweden, is a very considerable sum. In this furnace, e fuel is fed by a hopper, into a reservoir resting upon an inclined grate, pplied from below with air from a blower. The products of the combustion us maintained, pass through a condenser, where all the moisture in the gas condensed. The gas then passes to the heating-furnace, which is furnished th Siemens's regenerators." Lundin's furnace.

It is found easy to use fuel holding as much as forty-five per cent. of ter. The gas, as it issues from the producer charged with such wet el, contains one fourth its weight of watery vapor. It passes at once o a chamber in which, from perforated pipes, small streams of cold ter are discharged, crossing each other in various directions, and filling chamber. By this, the gas is greatly cooled, and the acid and tarry tters present, with much of the steam, are condensed. It then passes ough a second chamber, filled with wrought-iron bars, arranged like the cks in the heat-regenerators, and kept cold by a stream of water kling over them. The gas, which at the time of its escape from the ducer, was heated to the melting point of lead, is thus cooled down until etains only four per cent. of watery vapor.

" The expense of building a full-sized furnace, in Sweden, is about $2500 currency, and it is estimated that such a furnace will utilize 1700 tons of el in a year, at a saving proportioned to the cost of other fuel in the rticular locality where it is employed. In Sweden, it is estimated that e annual saving, resulting not merely from the fuel, but from the repairs the furnace, and the increased temperature, amounts to over $5000 r annum, on the product of each furnace. * * * * * * * * * * * The s produced by seasoned wood contains more water than that which oceeds from the Lundin condenser. The duration of the furnace is nply surprising, and is to be attributed, probably, to the fact that there no cinder. In eight weeks, the thickness of the roof, four inches, was only minished from ¼ to ⅛ inch, and the side-walls were entirely uninjured. wonderful is the success of this system of condensation, in connection th the Siemens regenerators, that, in Sweden, and, in fact, everywhere ere moist fuel is employed, the Lundin furnace will supersede every ner. Its great merit is, that it is available for any kind of fuel atever. In the United States it is believed that this arrangement ght be employed advantageously for washing the gas obtained from neral coal; but its chief merit consists in the fact that in mineral gions, far removed from the coal fields, it is possible to establish iron,

works, using saw-dust or peat with entire success and great economy. the lumber regions of Lake Superior it will be found to have a spe value, because there is an abundant supply of pig-iron, accessible to saw-mills on Green Bay and in Michigan, producing enormous quanti of saw-dust, slabs, and waste timber."

By the aid of the Lundin furnace, combined with the regenerator of Siemens, Rinman has succeeded in producing steel by the Martin cess, using only pine saw-dust for fuel. When such results can be obt ed with saw-dust, or with ordinary peat, the want of mineral coal need longer be an obstacle to the development of the metallurgical industry this country.

Boëtius's furnace.

The gas-furnace of Boëtius, which is now used for zinc-smelting, and many glass-works, in France, is simpler and less expensive than that of S mens. It does not make use of the regenerative principle, and hence waste heat can be employed or boilers or for other purposes. In this f nace, however, there being no condenser as in the Lundin system, o dry fuel can be made use of. The air which serves to burn the combu ble gases in the furnace-chamber, is heated by passing between the w of the generator and an outer casing, these walls being made very th and supported at intervals, by bricks, which are built both into th and their envelope. This furnace does not enable us to obtain a he sufficient for the production of cast steel, but is well adapted for puddli and reheating iron, as well as for zinc and glass-works, and is said economize from 30 to 33 per cent. of the fuel. This description is tak from a paper by Gruner, professor of metallurgy at the Ecole des Mines France, which appears, with working-drawings, in the *Annales des Mi* for 1869, fifth part. The same paper contains, also, descriptions, w drawings, of the Siemens-Martin steel process, besides an account of P sard's experiments, and of the Ellershausen process.

THE ELLERSHAUSEN PROCESS FOR MALLEABLE IRON.

Malleable iron.

The removal from cast iron of its carbon and silicon, and its conversi into malleable iron, is chiefly effected in two ways: of these the first consi in melting down the pig metal, before the blast, in an open fire known a hearth-finery or bloomary, somewhat resembling the bloomary hea used for the direct process of reduction in the United States. In t second method, the metal is melted and decarbonized in reverberatori known as puddling-furnaces. In the puddling process the carbon of t iron is removed, partly by the oxygen of the air, and partly by that of t oxyd of iron, which, in the form of iron ore, is used for lining, the sid

f the furnace, or fettling, as it is called, for which purpose large uantities of magnetic and hematite ores are consumed.

In both of these processes the cast iron is melted, but there are two ethods, which have have long been known, in which the decarbonization f cast iron, and its conversion into malleable iron, are effected without sion. In one of these, small objects of cast iron are imbedded in pulver- ed hematite ore, in carefully closed crucibles, and are then exposed for ree or four days to a red heat; when, if the size of the castings is not too eat, they are found to be decarbonized, and changed, throughout, into soft lleable iron. In this way are prepared the so-called malleable castings. Malleable castings. ery similar to this, in principle is, a process practiced in Wales some half a ntury or more since, and described by Percy, after Mushet (*Metallurgy*, Old Welsh process. 803). Granulated or shotted cast iron was mixed with a certain propor- n of bloomary cinder, rich in oxyd of iron, and the mixture exposed for ne hours, in covered crucibles, to a red heat. At the end of this time it s found that the grains of iron were decarbonized, and capable of being lded together; having been, in fact, converted into malleable iron by the ion of the iron-oxyd.

By another process, the use of the oxyd of iron is dispensed with, and iron is kept at a red heat, in contact with the air. In Tunner's method, Tunner's method. tes of cast iron, from one-half to three-fourths of an inch thick, are ked in boxes of quartz sand, so arranged as to permit the passage of and exposed to a glowing red heat for several weeks; at the end of which e the metal is found to be decarbonized, and converted into malleable iron. impurities which form fusible slags, appear, in these methods of pro- ing malleable iron, to be separated in a liquid form; sweating out, as it e, from the pores of the iron.

With these facts in mind, we are prepared to understand the results ained by Mr. Ellershausen, which have given rise to the process bear- Ellershausen's discovery. his name. In 1868, while making experiments on the production of l, he endeavoured to incorporate coarsely pulverized oxyd of iron with ten pig metal, with the intention of subsequently melting down the ture, and thus obtaining cast steel, by a process essentially the same that of Wood and Uchatius (page 293).

He found however, that the composite ingots of ore and pig metal, when ted on the hearth of a reverberatory furnace, did not fuse, but that the al was rapidly decarbonized, and, with the separation of a considerable unt of liquid slag, converted with malleable iron, which could be taken nce to the squeezer, and rolled into bars of a quality superior to those luced by the method of puddling.

t might at first appear that, as in the production of malleable castings, mingled oxyd of iron was the sole agent in thus decarbonizing and

effecting the conversion of the metal, but subsequent experime
have shown that by reducing the proportion of ore much below that requi
by theory, to effect the change; and even by replacing a portion of the
by powdered charcoal, whose effect would seem to be the reverse of c
dizing and decarbonizing, as good results were obtained as before. In
pig-bloom, as the aggregate of pig metal and ore is termed, the iron is m
subdivided, being partly in grains, and partly enveloping the granule
iron ore; the whole forming a somewhat porous aggregate, which is pe
ous to air, and thus offers a great extent of surface to its oxydizing act
as well as to the action of the intermingled oxyd of iron. Where an adı
ture of charcoal is used, it would soon be destroyed by combustion, anc
the action of the accompanying iron-oxyd, and the mass rendered still n
permeable to the air; so that the finely-divided white cast iron of the
bloom becomes rapidly decarbonized under the joint influences of the oxy
of the air and that of the ore. The ore, being in part reduced to the met
state by the carbon and silicon of the cast iron, tends to make the lo
iron less than in the puddling process. In this view, the Ellersha
method unites the reactions of the process for malleable castings, and
Welsh process above described, where oxyds of iron are the decarboni
agent, with that of Tunner, in which the decarbonization is effected by
oxygen of the air.

Theory of the process.

If we suppose the oxygen of the mingled iron ore to be the sole decar
izing and purifying agent, the reaction would be as follows: the carbo
the pig iron, with the oxyd of iron, would give rise to metallic iron and
bonic-oxyd gas; while the silicon, which the crude metal always cont
in variable quantities, would reduce another portion of the oxyd, libera
metallic iron, and forming silicic acid. This, in its turn, would unite
a portion of unreduced oxyd of iron, to form a fusible silicate or slag, o
composition already referred to on page 282.

If we take the magnetic oxyd of iron, the reaction with carbon woul
represented by

$$Fe_3O_4 + 4C = 3Fe + 4CO,$$

while with silicon we should have

$$Fe_3\,O_4 + Si = Fe + SiO_2,2FeO.$$

The above equations lead to the following results for each unit of
bon and silicon in the pig iron:

1 carbon requires 4·83 magnetic oxyd, and gives iron 3·5, carbonic oxyd 2·33
1 silicon " 8·28 " " " " " 2·0, silicate of iron 7·28

Thus a pig iron holding, for example, 95·00 per cent. of iron, 4·0
cent. of carbon, and 1·00 of silicon would require,

$4 \times 4{\cdot}83 = 19{\cdot}32$ of magnetic oxyd.
$1 \times 8{\cdot}28 = 8{\cdot}28$ " " "

27·60 " " "

ad should yield 16 parts of reduced iron, and 7·28 of silicate of iron. In ie case of some pig irons, which, in addition to 4·0 or 4·5 per cent. of rbon, contain 2·0, or even 2·5 per cent of silicon, the quantity of mag-etic oxyd required, according to the above formulas, would be greatly creased. In the trials on a large scale, for the production of malleable on by the Ellershausen method, at Pittsburg, Dr. Otto Wuth made care-l analyses of the pig metal, and the resulting products, both iron and slag. om these analyses it appears that when 100 parts of a metal, holding over 0 per cent. of silicon and 4·2 per cent. of carbon, were mixed with from to 30 parts of magnetic or hematitic iron ore, and treated as above scribed, the silicon, and nine-tenths of the carbon were removed, together th most of the sulphur and phosphorus. At the same time the resulting ig was much richer in iron than that obtained in puddling the same iron, , indeed, than most slags from the puddling-furnace. It contained an iount of iron equal to not less than 64·7 per cent. of metal, and it 8·95 per cent. of silica, while the saturated silicate of iron, whose for-ıla is given above, contains but 54·9 per cent. of iron, and 29·4 per cent silicon. The highly basic slag from the Ellershausen process, as anal-ed by Dr. Wuth, has thus a composition corresponding to a mixture about 30 per cent. of a saturated silicate of protoxyd of iron, (with small rtions of lime, magnesia, and alumina,) and 70 per cent. of magnetic yd of iron. Wuth's analyses.

From this it appears that a large part of the ore added to the pig metal not consumed, but passes off in the slag; and it would seem that, in this se, the principal action of the oxyd of iron had been the removal of the ydized silicon. Each unit of silicon furnishes by its oxydation an amount silica which requires at least four units of iron, in the state of protoxyd, its conversion into the ordinary fusible silicate of iron. All of this yd of iron, in the ordinary puddling-process, except so far as furnished the fettling, must be derived from the oxydation of the metal, and hence great waste with highly siliciferous cast iron in the puddling-furnace. r such irons, therefore, the Ellershausen process would seem to be ecially adapted. Silicious iron.

Were the conversion of the iron to take place according to the formulas eady given, solely by the action of the oxyd of iron on the carbon and con of the pig metal, 100 parts of this, having the composition above igned, should yield theoretically, supposing no subsequent loss of iron oxydation, or otherwise, 111 parts of pure iron; since to the 95 parts sent in the pig metal, would be added 16 parts reduced from the oxyd, the carbon and silicon. In practice, however, the gain is much less n this, leading to the conclusion that a part of the carbon is oxydized atmospheric oxygen, while much of the added iron-oxyd must escape Theory of the process.

unreduced, in the slags, as we have seen is really the case. According Dr. Wuth, the result of the treatment of nearly 4000 tons of iron by Ellershausen method, as above described, with about 28 per cent. of ox of iron, showed a gain of not quite 5 per cent. on the weight of the iron employed.

These conclusions are confirmed by recent results of the iron-works Messrs. Burden, at Troy, New York, where the Ellershausen process been found to give satisfactory results, with 15 per cent of magnetic ir ore, although the quality of the product was improved when 20 per ce of ore was used.

Analyses of the pig metal, the ore, and the products, in such trials will most important as serving to shed farther light on this new process. Me while the following suggestions with regard to it seem warranted by facts before us.

Suggestions for practice.

1st. The ore used should be as free as possible from i purities. Silicious matters, by uniting directly with the oxyd of iron, occ sion a large loss of ore; while lime, magnesia and alumina-compounds, only increase of the bulk of slag, but render it pasty and difficult to removed from the iron. 2nd. The ore should be finely divided, inasmu as more surface will thus be presented to the iron. In the working of process at Pittsburg, much of the ore added was in coarse grains, wh escaping, dissolved in the slag, but otherwise unchanged, caused this be, as we have seen, extremely rich in oxyd of iron. The coarse grai it may be supposed, serve however to give to the aggregate that mecha cal condition which is favorable to the proper working of the process result which would probably be equally well secured by the admixture c portion of charcoal; an experiment, which I am informed, has already be successfully tried at Pittsburg. The use of a greatly reduced proport of finely divided and very pure ore, together with a portion of coars ground charcoal, would therefore seem to promise the best and m economical results with the Ellershausen process. Rich hematite, free fr

Choice of ores.

silica, or magnetite, previously calcined, and if necessary, purified, af crushing, by the aid of a magnetic machine, should be tried. The magne portion of the fine iron sands from the lower St. Lawrence would prob bly yield excellent results in this process. Some experiments made Pittsburg, in which the purified iron-sand was used in place of the ordina ores, are said to have given a superior quality of iron. The ores used the trials which gave the products studied by Dr. Wuth, were, howev the magnetite of Lake Champlain, with some hematite from Missouri.

From what has been said, it will be evident that the supply of air in t furnace should be as abundant as in the process of puddling, and tha reducing or feebly oxydizing atmosphere therein, would either grea modify the conditions of the Ellershausen process, or lead to failure.

The novel invention of Ellershausen, on which his patent is based, is the mixing of crushed or pulverized ore with the molten metal, as it flows from the blast-furnace or cupola, thus forming masses of conglomerate, which are subsequently exposed to heat in a reverberatory furnace. The mingling f the two, was, in the first experiments, effected by pouring them simultaneously into an ingot-mould, while the mixture was stirred with a wooden pole. This method, however, is replaced by an ingenious arrangement of a large horizontal turning-table, around the periphery of which is a trough, divided, by partitions, into a series of compartments, into which the ore and he liquid metal are simultaneously discharged. The table being made to evolve, each compartment receives, in succession, a thin layer of mingled re and metal, more or less intimately mixed, and the process is continued ntil the moulds are filled; when the consolidated masses, composed of successive layers, not over four tenths of an inch in thickness, are removed, nd are ready to be placed in a common puddling or other reverberatory urnace. Here, at a white heat, if the proper conditions have been observd, the conglomerate softens, without melting, the slag begins to flow out, nd the iron is soon ready for the operations of squeezing and rolling.

Turning table.

It is claimed for this process for the production of malleable iron, that it equires much less time than puddling; the average time required for the reatment, in an ordinary single puddling-furnace, of a charge of 800 pounds f the conglomerate, producing about 600 pounds of muck-bar, not eing over an hour and a quarter. The consumption of coal is reduced bout one-half, and the ordinary labor of the puddler is done away with, the masses in the furnace requiring but little manipulation. The rapid wearing f the furnace-bottom, which in puddling, causes such a loss of time, is lso obviated. In addition to these advantages, which in Pittsburg, is claimed, effect a saving of eight or ten dollars a ton, it is found hat the iron produced in this way is superior in quality to that obtained om the same pig metal by the process of puddling. This superiority is pparently explained by the fact, established by Dr. Wuth's analyses, that he sulphur from the pig metal is more completely eliminated by the llershausen process than by puddling. The analyses, with a summary f the report will be found in the *Chemical News*, American edition, in the upplement for October, 1869; and with Dr. Wuth's report, in full, in sborn's *Metallurgy of Iron*, page 565.

Advantages of the process.

The Ellershausen process is now regularly worked at Pittsburg, by lessrs. Shoenberger and Co., and in one or the other places in the United tates; and in the opinion of some who are best qualified to judge, is desned to general adoption. Its introduction has been retarded by various uses, among which are the jealousies of puddlers, and, in some cases, by artial failures, the probable causes of which have been pointed out in the receding pages.

Granulated iron.

Numerous patent-claims, from that of John Wood, in 1761, down to present time, have been based upon the use of granulated or pulver cast iron for the production of steel or malleable iron. The iron is gra lated by beating in large mortars, when heated nearly to its melting po or by causing it to fall into water, through the air, or upon a rapi revolving disk, from which it is thrown off by centrifugal force. grains of iron, more or less oxydized at the surface, are directed to be veyed to a furnace, and there formed into lumps for the rolls or hamm or else mixed with oxyd of iron, and exposed to heat in a furnace, (c close vessels) whereby a malleable iron, fit for the manufacture of stee obtained. See, among others the specification of Bousfield, in 1857, 3082, and that of Morgans, in 1865, No. 806, of the British Pa Office. In so far as these propose to work in the open furnace, they d from the old method of Wood, and the Welsh process, already descri page 299, and approach to the conditions attained in the Ellersha process. Excellent results have recently been obtained by Mr. Hewi Ringwood, New Jersey, by mixing the granulated cast iron, with iron in grains, and exposing the mixture to heat on the hearth of a reveberat when decarbonization, and conversion to malleable iron takes place, as Ellershausen's method, without fusion.

It had been proposed, as mentioned on page 211, to give in a t part of this report, some chemical and mineralogical notes with regar the gold, silver, and bismuth ores of Hastings county, Ontario. results of my analyses, so far as they are of economic interest, the principal facts relating to the mode of occurence of these c have, however, been furnished to Mr. Vennor, and are given on pa 170–171 of this volume. The report has, moreover, exceeded the li originally proposed for it, and it has therefore been thought best to d the publication of many interesting chemical and mineralogical de to another occasion.

REPORT

BY

MR. JAMES RICHARDSON,

ADDRESSED TO

ALFRED R. C. SELWYN, Esq.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

North shore of St. Lawrence.

Sir,—In the month of May last I was instructed by Sir W. E. Logan o make a geological examination of the north shore of the lower St. Lawence from the River Saguenay to the Bay of Seven Islands, a distance of bout 220 miles; I was also directed to ascend one or more of the princial rivers on the coast. Those selected were the Manicouagan and Berimis; the former was surveyed for about forty miles up, while the latter, hich had already been surveyed by Admiral Bayfield, was ascended for distance of thirty miles. A map of the area examined has been onstructed on a scale of four miles to one inch, on which the geological acts and other characteristics of the country are laid down.

South shore.

Having completed my survey of the north shore, about the middle f September, I returned to Montreal, and was then ordered to proceed to rois Pistoles, on the south shore of the St. Lawrence, and continue to the orth-eastward my work of 1868, which had terminated at that point, and as resumed and carried along the coast as far as Father Point, a distance f about forty miles. Examinations were also made along several transerse lines of from four to ten miles, in a south-east direction; more facts re, however, wanting before my results in this district can be given in a omplete form.

On the north shore the geological formations of the area examined are:

1. Laurentian gneiss.
2. Labradorite rocks.

Laurentian gneiss.

The Laurentian gneiss sometimes has little appearance of stratification; e strike is generally nearly north and south, with dips often approaching ertical. The strata are all more or less broken, contorted and faulted.

The labradorite-rocks rest unconformably on the Laurentian; they ge rally strike nearly east and west, and dip at comparatively moder angles, with little or no appearance of contortion or disturbance.

The Laurentian rocks consist chiefly of coarser and finer redd and greyish gneiss, often syenitic, and marked by dark bands holding m hornblende or mica. A coarsely granitoid reddish syenitic gneiss observed at the following localities, viz:—Ten miles up the Bersimis; the Outarde River from the tide-way, for a distance of five miles; and the coast a little east of the Papinachois.

Intrusive diorites.

At Escoumains a fine white granitoid gneiss occurs, composed of p white feldspar and quartz, with, rarely, small grains of black hornblen In the neighbourhood of Point de Monts and Trinity Bay, considera masses of a fine gray diorite, which appears to be intrusive, are fo among the gneisses, and numerous dykes of black fine-grained trap also met with in the vicinity.

Crystaline limestone.

On the coast, two miles east of the Papinachois; on the north side the Government Road, about a mile east of the Great Bergeron Cove; a about sixteen miles up the Manicouagan River, at the foot of the seve portage, vitreous quartz rock occurs in masses of from 50 to 120 fee thickness. Some of this rock is very pure, and might be used for gl making; but much of it holds sparingly disseminated plates of flesh- feldspar, and a pale green steatitic mineral. About twelve miles up river last named, there occurs in the gneiss a bed, twelve feet thi of coarsely crystalline limestone, gray, yellowish, and occasionally pinl in colour, and holding grains of green pyroxene; this, with the except of a thin seam of dolomite found at Lobster Bay, is the only Laurent limestone observed during the season.

Labradorite rocks.

The labradorite rocks along the coast examined offer many varietie character and aspect, but are generally bluish or greenish in colour, m resembling those found to the north of Montreal; in one case beds w met with holding considerable quantities of red garnets in lumps up to h an inch in diameter. Some of the beds contain much black mica, a others nodules of a gray fibrous hornblende approaching actinolite; va ties of the labradorite rock were also met with holding hypersthene, a small masses or layers of magnetic iron ore.

The first locality to be noticed, where these rocks occur, is at the mo of Pentecost River, and for about half a mile to the north-eastward. T rock is here banded with coarser and finer varieties, holding small lumps red garnet, mica, actinolite and iron ore, which make its stratification v apparent; it dips with much regularity N. 23° E. < 30° to 40°, as m be seen for half a mile along the shore; which here trends nearly north a south, in a succession of low bluffs, seldom above thirty feet in height.

In Lobster Bay, half a mile further to the eastward, after an interval of ncealment, the reddish quartzose granitoid rock of the Laurentian is ain met with, offering no evidence of stratification; and in one place is en to be distinctly overlaid by a patch, only a few yards square, of radorite-rock, shewing considerable varieties in character, and clearly atified, with a strike N. 53° E. Labradorites.

Labradorites are the only rocks seen from the May Islands to Point St. rgaret, and also at the falls of the river of that name, the interval being cealed by sand. Rocks of the same series were observed by Dr. Hunt the head of the Bay of Seven Islands, enclosing a large mass of titanic ore, and they form also the great southern promontory of the bay, ere the rock is generally more or less coarse-grained, greenish-blue in our, and holds hypersthene and titanic iron ore. The dip of the beds of radorite-rock, as seen here along a distance of three or four miles, is erally uniform to the north, at angles of from 10° to 20°. At the falls the St. Margaret the dip is N. 28° E. < 22°, while at Point St. Maret it is S. 32° E. < 82°.

3oth the Laurentian gneiss and the labradorites are cut by granitic veins, etimes of considerable width, made up of large crystalline masses of p red orthoclase, often with a pale green feldspar, probably oligoclase, k crystalline hornblende, vitreous quartz, and sometimes crystalline ses of magnetic iron ore. Granite veins.

3esides the above crystalline rocks, a small patch of Silurian limestone Silurian limestones. irs on the east side of Manowin, one of the group of the Seven Islands. beds of this light-coloured fossiliferous Silurian limestone are seen to se on reddish gneiss, and dip northward at an angle of from 2° to 6°; fossils, according to Mr. Billings, shew it to belong to the Trenton ip; it has been quarried for use at the Moisie iron-works, near by.

addition to the economic materials already mentioned, the iron sands Iron sands. is region, which have attracted considerable attention, may be noticed. deposits of these sands at Moisie have been examined by Dr. Hunt, has shewn that they belong to the stratified silicious sands of the dis-, which here overlie the old marine clays, at considerable heights above resent sea level. In many places I observed beds holding so much iron s to shew dark or nearly black layers among the gray and brown sili- sands. They were seen, of this character, at various places along oast, at heights up to 100 and even 200 feet above tide-level; while he Manicouagan River, twenty-four miles from its mouth, where it ns a height of 256 feet above the sea, the banks of sand exhibited the dark-coloured bands of iron sand, from forty to fifty feet above the r.

the coast between Portneuf and Sault au Cochon, and also between

the River St. Margaret and the Bay of Seven Islands, hills of post-tertia clays, containing marine fossils, and attaining heights of from 50 to 1 feet, are often seen to be capped with from forty to fifty feet of similar f and coarse brown sand, banded with dark layers likewise charged w black iron ore.

Iron sands.

The rich accumulations of ore which are seen along the beach appe as Dr. Hunt has remarked, to result from a natural process of concent tion by the action of the water upon these sands; they were observed i great many places on the coast, about high-water mark, in strips from th to nine and twelve feet wide, and from two inches to two feet in thickne often extending without interruption, for miles. It is said that the visi extent and the richness of these local deposits is somewhat affected by varying action of the wind and water. The places at which I noti these belts of iron sand along the portion of coast examined are as follo viz:—

1. The vicinity of Tadousac, for a distance of three miles downward

2. From Jeremie to Bersimis, and thence to the Papinachois, a dista of twelve miles.

3. The peninsula at the mouths of the Outarde and Manicouagan riv for thirty miles.

4. From English Point to Pentecost River, for eight miles.

5. The coast on both sides of the St. Margaret River for ten mil making in all sixty-six miles.

In all these places except the first named, near Tadousac, I think t the quantity of ore is such that it might be collected with profit, especi by the aid of proper concentrating machinery. Water-power, if need is accessible in several localities near the iron sands; among others, at falls of the River Baude, on the coast, three miles below Tadousac; at falls of the Papinachois, also on the coast; at those of the Outarde Manicouagan, at the head of tide-water (respectively twelve and fift miles from the general trend of coast): at a fall in a stream, on the co half a mile north-east of Pentecost River; and at the falls of the St. M garet, three miles from the coast.

The mouths of the Bersimis, Papinachois, Outarde, Manicouagan, P tecost, and St. Margaret, all afford safe harbours, with sandy bottoms, wh vessels drawing twelve feet of water may enter at high tide, although access is somewhat difficult, on account of numerous sand-banks. In a of them a wharf extending from forty to fifty feet from the shore would sufficient to reach the channel.

Geographical features

The surface of the whole region examined, with the exceptions m tioned below, is broken and irregular. The hills of hard rock occasiona attain a height of upwards of 2,000 feet, besides which, there are hills

atified clays, capped by sand, often rising 200 feet or more ; and in one stance near Tadousac, 400 feet.

A very thin soil occasionally occurs on the rocky hills, but, generally er large tracts where fires have destroyed the vegetation, little remains t a bare surface of solid stone.

On the portion of the coast between the Saguenay and the Outarde, Forest trees ere the soil permits, there is timber of fair size, consisting of yellow ne, spruce, balsam-fir, tamarack and white birch. Yellow pine was for- rly cut on the Portneuf River, and considerable qu antities still remain the rivers Escoumains, Sault au Mouton, Sault au Cochon, Bersimis, d Papinachois. Pine logs, as I saw them at the mills, and in the est, were from twelve to twenty inches in diameter. Beyond the river tarde no yellow pine is met with, and from thence to the Seven Islands, other trees are smaller, and the barren portions are more extended.

From Tadousac to the River Baude, a distance of about three miles along Soil. coast, there extends a belt, less than a mile in width, of yellowish- own sand, mixed with thin layers of the iron sand already noticed. llowing the river just named, for about two miles northwardly, the clays adually come out from beneath the sand, and afford an excellent soil. e Hon. David E. Price, Senator, informed me that this kind of soil etches northward towards the St. Margaret River, and is of considerable tent; but it is not accessible for want of a road. On the Little Ber- ron Cove and River, there is a strip of similar good soil, four or five les long by about a mile wide, and on the Great Bergeron Cove, there from 1,000 to 1,500 acres of excellent land, yielding good crops of getables, and all kinds of grain.

From the cove last mentioned, to the Escoumains, a plain extends from shore to a bare ridge of reddish gneiss, from two to seven miles inland, d occupies an area of forty to fifty square miles. The soil of this in is a coarse brown sand, with patches of moss, probably in depres- ns, and sustains a growth of blue-berry and other shrubs, with a few nted spruces, balsam-firs and white birches. Some attempts have here en made at farming, but with very little success, except at a few spots the coast, just to the west of Cape Bon Desir, where the clay, which derlies this sand, has been uncovered by land-slides.

From the village of Escoumains, at the mouth of the river of that name, Mille Vaches Bay, a distance of about twenty miles, extends a belt of d like that just described, and from one to two miles in breadth, with casional protruding spurs of gneiss rock. Here, as before, the only suc- ssful attempts at cultivation are confined to spots where the underlying y has been exposed by the cause above mentioned.

From Mille Vaches Bay to Sault au Cochon, a distance of twelve miles

Cliffs of clay and sand.

a similar sand plain prevails along the coast, also extending about two r
inland. From the last mentioned point to the Portneuf River, clif
clay, capped by sand, rise boldly up from the shore to heights of from
to 200 feet. These cliffs, which have already been mentioned in spea
of the iron sands, have in their lower part from fifty to probably one
dred and fifty feet of fine blue clay, in which the fossil remains of the *Ma*
villus, or capeling, and several species of recent marine shells,
found imbedded. The brown sand, often forty or fifty feet in thick
which overlies these clays, presents alternate coarse and fine layers,
is banded with others holding black iron sand. Beyond Portneuf to
mie, a distance of about fourteen miles, the coast is rocky, and affords
a few isolated patches of sandy soil; but from Jeremie to Point St. Gile
the mouth of the Manicouagan, a distance of nearly forty miles, there
recurrence of the sandy plains, with occasional protruding masses of
gneiss rock.

Along this coast considerable portions of land are covered with mos
may be seen just to the east of the Indian Village and Hudson Bay C
pany's post at Bersimis. These sandy tracts include a part of the B
mis Indian Reserve, together with the peninsula between the mouth o
Outarde and Manicouagan Rivers, and have an extent which may be app
imately estimated at 200 square miles. In ascending the Bersimis R
for about thirty miles, occasional patches of from 200 to 1,000 acre
sandy soil are met with, lying between rocky ridges.

River Manicouagan.

In ascending the Manicouagan River from a point twenty-four r
from its mouth, to the Forks, fourteen miles further, is a reach of
water, with a gentle current, between banks from ten to fifty feet h
composed of brown sand, with layers holding the usual black iron ore.
river here, as already mentioned, is 256 feet above the sea, and the va
which is about a mile in width, is walled in by ridges of gneiss rock, r
above it to heights estimated at from 300 to 1,500 feet, often bare of v
tation. This sandy valley supports in most places a stunted growt
spruce, balsam-fir and white birch, but at the Forks, and for about
miles below, the soil is a loam, and produces a growth chiefly of poplars
white birches, which attain a fair size; one of the latter, which I cut d
was eight inches in diameter at the base, and 102 feet high; its age, ju
ing from the rings of growth, was between sixty and seventy years.

From Point St. Giles to the Godbout River, a distance of twenty
miles, the coast is mostly rocky and barren, with the exception of about
acres of sandy soil at the mouth of the river, surrounded by rocky gr
hills; thence to English Point, a distance of thirty-five miles, the countr
still mostly barren and rocky. From English Point to Pentecost Ri
about eight miles, another belt of similar sandy soil occurs, with
average width of from one to two miles.

From Pentecost River to Point St. Margaret, twenty-seven miles, it is gain barren and rocky—thence to Seven-Island Bay, a distance of venty-four miles, and also to a few miles beyond the River Moisie, a furer distance of thirty miles, a similar, sandy soil occupies a belt of country, arying in width from one to about twelve miles; the whole giving an rea of about 500 square miles. In the rear of the belt between Point t. Margaret and the Moisie River, bare rocky hills are seen, having an verage height of nearly 1,000 feet.

In the interior, areas not observed, of the same kind of soil, may be met ith; but they are probably small in extent and difficult of access. lthough these sandy soils are capable of being cultivated, a superior nowledge of their management is required to do so successfully.

I have the honour to be,

Sir,

Your most obedient servant,

JAMES RICHARDSON.

Montreal, 18th April 1870.

REPORT

BY

MR. ROBERT BELL, C.E., F.G.S.,

ADDRESSED TO

ALFRED R. C. SELWYN, Esq.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

IR,—I have to report that, in compliance with the instructions which I the honor to receive from Sir W. E. Logan, I proceeded, in May last, ıake a geological examination of the country lying on the north-western of Lake Superior. Fort William was selected as my head-quarters for season, from its being the most conveniently situated point for our explo- ons in the region around Thunder Bay, and from having a post-office, frequent steamboat communication with the east, and because we could find safe storage for our provisions and outfit. We were under many gations to Mr. McIntyre, the gentleman in charge of the Hudson Bay pany's establishment at Fort William, for the accommodation of one of storehouses, for advice and assistance in procuring proper guides, for use of boats and canoes, for tracings of various maps in his possession, much valuable information of all kinds, which his long experience in region enabled him to give in regard to the country which we nined, and for his kindness and attention generally in promoting the cts of the expedition. We were also greatly indebted to the families Mr. McIntyre, Mr. McVicar and Mr. McKellar for their kind itality whenever any of our party happened to be at Fort William. officers and employés, generally, of the Hudson Bay Company aided us rfully whenever an opportunity occurred. Amongst those from whom received information or assistance, I may mention Mr. Hopkins of treal, Mr. McKenzie of LaCloche, Mr. Bell of Michipicoten, Mr. rles De La Ronde of Red Rock, Mr. Crawford of Nipigon House, Mr. ry De La Ronde of Poplar Lodge, Mr. Whyte of Basswood Lake

Acknowledgement, of aid.

and Mr. Pether of Fort Frances. Before starting from To
Mr. Andrew Russell, of the Crown Lands Department, very
furnished me with tracings of maps, and with extracts from r
relating to the country to be explored. I am indebted to Mr. T
Herrick, P.L.S., for his plan and field-notes of the survey whi
made of the Nipigon River; to Messrs. Peter, John and
McKellar for the results of their geological explorations in the c
from Pigeon River to Black Bay, and back to a considerable di
beyond Dog Lake, and for numerous topographical features, inclu
plan of their survey of Current River; also to Mr. H. P. Savigny, P
of Toronto, Mr. Hugh Wilson, P.L.S., of Mount Forest, Mr.
Dawson, C.E., Mr. W. B. Borron, Inspector of Mines at Fort Wi
Captain Symes of the steamer Algoma, and Chief Manitousa
Nipigon, for their kindness in aiding our exploration in various way
Assistants. was assisted in the labors of the season by Messrs. P. McKellar of
William, P. B. Ball of Guelph, A. D. Blackader of Brantford
Notman of Hamilton, A. McKenzie of Clifton, W. W. Russell of To
C. E. Dobbs of Kingston, and P. McLaren, B.A. of Lanark.

The first month was devoted to an examination of the coast
Prince's Bay to Fort William, the country between this section of the
and the lower stretch of the Kaminitiquia River, the valley of this
the country between Thunder Bay and Dog Lake, and the sho
Thunder Bay. As required by my instructions, I paid particular
tion to the geology of the silver deposits of this region, which prom
be of importance.

In addition to the district first referred to, I was directed to ma
Lake Nipigon. exploration, or if possible, a survey of Lake Nipigon. In tracin
run of the rocks eastward and northward from Thunder Bay, I found
many advantages would be gained by proceeding to this lake as ea
the season as possible. By doing so, I hoped to have enough o
summer left to make considerable topographical surveys in that re
which would serve as a correct basis for laying down our geological
In June last, I had the honor to communicate to Sir William Loga
letter from Fort William, my reasons for believing that the Huronian
Upper Copper-bearing rocks would be found to occur around Lake Nip
In extending our explorations in the region assigned to me, from
Thunder Bay side only, we were constantly in the dark as to the ge
nature of the geology of the country ahead of us. Whereas, by map
that of the Nipigon district, we should have determined the geolo
the two sides, and thus rendered it much easier to work out that o
intervening area. Having ascertained from the officers of the Hu
Bay Company and the Indians, that Lake Nipigon was much larger

nmonly supposed, and considering how desirable it would be, for our rposes, to have a complete traverse of its shores, I engaged Mr. Peter :Kellar of Fort William, who is both a surveyor and a geologist, to assist in the undertaking; and the result proved that I was very fortunate loing so.

Before starting from Fort William, I had the honor to receive the litional instructions, which had been forwarded to me by Sir W. E. gan, at the suggestion of the Honorable Mr. McDougall, then Minister Public Works. These directed me to take levels, and to make all sible observations with a view to ascertaining the practicability or erwise of a railway to the North-west Territories through the country ich we might examine. I am happy to have been able to report that explorations have enabled me to trace a route which appears to be te practicable for such a purpose, as far as we went, or through a tance of about one hundred miles in the proposed course, beginning Lake Superior. In the following pages, I propose to add some details hose which were contained in the special report of 22nd February this subject, which I had the honor of addressing to you. *

The Nipigon River having been carefully surveyed by Mr. Herrick, it remained for us to make what geological observations we could, while ending it. Having arrived at Lake Nipigon, I divided our party, and e Mr. McKellar charge of one of the sections. Beginning on the th side of the lake, at the point where Mr. Herrick's line intersected shore, Mr. McKellar proceeded to the right, or east side, while I took west. At the end of about eight weeks, the two parties met at northern extremity of the lake, having completed a survey of its res, excepting the deepest parts of a few of the bays. We had also lored, and in some cases surveyed, the lower reaches of the principal rs entering the lake, and determined the positions and forms of ut 460 of the islands, lying within easy reach of the shore, and more ghly the positions and outlines of about 100, lying further off; while time not permit of our ascertaining, personally, anything with regard to a siderable number in the centre of the lake. When on the south-west , I made a journey of several days into the interior, following the lakes streams, and making portages between them. In this excursion, I guided by Chief Manitousaise's son, Tchiatang, a very intelligent ian, whose services I had secured for the summer; and I had on this asion, an opportunity of proving the accuracy of the sketch-maps of the ion which he had previously made for me. This man had travelled a at deal in the Nipigon country, and beyond it. Having a very correct of distance, by using a compass, laid upon the paper, to guide him as Plan of Survey.

Transmitted to the Honorable Secretary of State for the Provinces.

to direction, he prepared for me a number of sketch-plans, shewing geography of the districts through which he had travelled, together wi great deal of other useful information. The country south of Gull on Lake Nipigon, was explored by following the Kabitotiquia River making a portage from it to Chief's Bay on the same lake.

Measurements.

Our surveys on either side of Lake Nipigon, which were effected m by triangulation, were carried on in two bark canoes. Dista were checked and details filled in by the Rochon micrometer. angles were determined by the sextant and Troughton's repeating ci the local magnetic variation being so great and so uncertain as to re the compass of little use on most parts of the lake-shore. A true meri was occasionally laid down, by which to fix the directions of our li and latitudes were taken for the purpose of checking our measurem The heights of some hills were ascertained by angles of elevation, o means of two aneroid barometers, which were also used in determining amount of fall in the rapids of the Nipigon River.

Black Sturgeon lake and river.

In returning from Lake Nipigon, Mr. McKellar made an actual su of the west shore of Black Sturgeon Lake, and of the river of the name, as far down as Nonwatan Lake, and an approximate one from lake to its mouth; whilst I, returning by the same stream, made traverses of the country lying between it and the Nipigon River. O return to Lake Superior, a partial examination of the north-west sho Black Bay was effected; some additional explorations were made o north side of Thunder Bay, and along the Red River Road, as far as i been opened, after which the work of the season was brought to a c and the party returned home, all well.

Throughout the season, I worked upon the principle which we always pursued upon the Geological Survey, in exploring or surveyin a new region, namely, that of following, as much as possible, the w courses, instead of cutting "exploratory lines" in the woods. The follo may be mentioned amongst the many advantages of this system: (1) avoid the expense of cutting the lines, which would add but little to our k ledge of the natural features of the country, and would soon be obliter (2) The clear space afforded by the surface of the water serves b than an artificial opening in the woods for measurements by the m meter, which may be made as accurately as by the chain. It admits of triangulation, which is impossible in the forest. (3) A gr distance may be surveyed per day. (4) A smaller party can do the w (5) The canoes or boats by which the survey is carried on, also ser convey, at the same time, the supplies of the party, and allow of a cons able quantity being taken, thus enabling the work to go on continuo for a greater distance, or a longer time, without reference to the bas

erations, than where everything has to be carried on men's backs. (6) ne river-beds and lake-shores afford many more exposures of the rocks an are to be met with in the woods, where they are covered by earth or oss. (7) The same measurements, which serve to determine correctly e distribution of the rock-formations, also enable us to lay down the pographical features of the country, and thus we obtain a knowledge of geography simultaneously with that of its geology.

The principal results of the season's operations may be briefly summed as follows: Summary of season's work.

1. The working out of the geology of the country around Thunder Bay, cluding an area of the Huronian system not previously recognized, and e addition of many new facts in regard to the mineral veins of this gion.

2. A survey of Lake Nipigon and portions of several of the rivers flowing to it, and the obtaining of approximate levels along the Nipigon River, sides an examination of much of the country near Lake Nipigon.

3. Ascertaining the fact that a large area north of Lake Superior, includ- g the Nipigon country, is occupied principally by the Upper Copper-bear- g and Huronian rocks, instead of the Laurentian, as had been supposed, d that it therefore offers a greater probability of the discovery of valuable nerals, and besides, affords a much better country for colonization and the construction of highways.

4. The discovery of an apparently easy route for a railway to the North- est Territories through the country explored, for a distance of about one ndred miles from the mouth of the Nipigon River on Lake Superior.

For the sake of convenience, the tracts examined will be described in the lowing separate sections as: 1. The Thunder Bay region, embracing e country from Pigeon River to Black Bay. 2. The valley of the ack Sturgeon River. 3. The Nipigon River. 4. Lake Nipigon and the rrounding country. These will be followed by sections on the economic nerals of the district examined, surface-geology, soil, timber, climate, e opening of the Nipigon country for colonization, the railway route, and ner matters.

I have laid down our surveys of Lake Nipigon and the rivers entering it, Geological map d of Black Sturgeon Lake and River, together with Mr. Herrick's survey the Nipigon River, and Admiral Bayfield's of a portion of Lake Superior, in a connected form, on a scale of one inch to the mile, upon the large eet accompanying this Report. It was satisfactory to find, on plotting e work, that the measurements of Mr. McKellar and myself, around the posite sides of the lake, closed very well. The accompanying map of e whole country between Pigeon River and Nipigon Bay on Lake perior, and northward to the waters flowing into the Albany River, on

a scale of one inch to four miles, is based upon Mr. Robert Barlow's co laiton of all the actual surveys which have, at any time, been n within that region, with the addition, by myself, of the other featu as nearly as they can be laid down, from all other sources available u the present time. Upon this, I have represented the geology, as far has been determined by Sir W. E. Logan and Mr. Murray, and from explorations of last year, with the addition of the information derived Mr. McKellar and others already mentioned.

GEOLOGY.

The rocks of the country examined during the season belong to Laurentian, Huronian and Upper Copper-bearing series. For the sal facilitating my description of

THE UPPER COPPER-BEARING ROCKS,

Upper Copper-bearing rocks.

I will introduce the following list, which represents, in ascen order, the subdivisions of this series, as far as known, in the region u consideration. It is prepared from the descriptions by Sir W. E. Lo in the *Geology of Canada*, and those by Mr. Thomas Macfarlane ir *Canadian Naturalist*, as well as from our own observations during past season. As this district is, even yet, but imperfectly examined, s portions of the series may have been overlooked, and, therefore, this visional arrangement of its members may require modification at s future time. The figures in brackets are only a rough approximatio the thickness in feet, and are given provisionally, merely to convey idea of the proportionate volume of each division.

Lower Group.

Lower gronp.

1. Conglomerates composed of pebbles of quartz, jasper and gree slate, in a greenish arenaceous matrix. Seen on the north shore of T der Bay. (70)

2. Chert layers, mostly thin and having a ribbon-like appearanc cross section. The mass is generally dark, but some light-colored la occur. Thin beds of dolomite sometimes separate the chert layers f one another, and argillaceous layers are also occasionally interstratif while bands of dolomite, which are themselves sometimes separated by a laceous beds, are interstratified with the foregoing. The chert bands tain iron pyrites in specks, nodules and thin interrupted layers. A eral resembling anthracite also occurs in the rocks of this and the follo division. Seen at the eastern extremity of Thunder Bay, and near five-mile post on the Red River road. (300).

. Darkly colored massive argillites and flaggy black shales, the mass ıg characterized by numerous vertical joints, running in two directions, dividing it into blocks of a very symmetrical character. The shaly ions hold regularly formed spheroidal concretions of various sizes. p beds are associated with these rocks along the north shore of Thun- Bay, at the Thunder Bay Mine and in the township of McIntyre. shales are seen on the lower part of the Kaminitiquia River, espe- y at the Grand Falls, and along the coast of Lake Superior, between William and Pigeon River, while an example of the massive variety be seen in the workings at the Thunder Bay Mine. (450)

Gray argillaceous sandstones and shales, mostly thinly and evenly led, fine grained and slightly calcareous. Examples of both of these s may be observed on each side of Thunder Cape, and in the township IcIntyre. In the southern part of this township, and at the north- ern corner of Neebing, bands of sandstone, supposed to belong to this sion, occur, containing a large percentage of magnetic iron ore.)).

Upper Group.

Alternating red and white dolomitic sandstone, with a red conglom- e layer at the bottom, occurring on Wood's Location, Thunder Cape. Macfarlane finds the red sandstone to contain 12½ per cent. of onate of lime, and 11 per cent. of carbonate of magnesia. (40). Upper group.

Light gray dolomitic sandstone, with occasional red layers, and spots patches of the same color. These sandstones occur along the south- side of Thunder Bay, and on Wood's Location, where Mr. Macfarlane d them to contain 13 per cent. of carbonate of lime and 12 per cent. ırbonate of magnesia. (200).

. Red sandstones and shales, interstratified with white or light gray stone beds, frequently exhibiting ripple-marked surfaces, and also with lomerate layers, composed of pebbles and boulders of coarse red jasper matrix of white, red or greenish sand. (500).

Compact light reddish limestones (some of them fit for burning into k-lime,) interstratified with shales and sandstones of the same color.).

Indurated red and yellowish-gray marl, usually containing a large ortion of the carbonates of lime and magnesia, the amount varying in imens analysed by Mr. Macfarlane, from 21 to 34½ per cent. of the er and from 7½ to 13½ of the latter. This division runs through the re of the peninsula between Thunder Bay and Black Bay, and may, is region, have a thickness of 350 feet or more. (350).

10. Red and white sandstones with conglomerate layers, the red stones being often very argillaceous, and variegated with green spot

Upper Copper-bearing series.

streaks, and having many of their surfaces ripple-marked. These are found all along the north-west side of Black Bay as far up as the ship of McTavish. (200).

11. On the opposite side of Black Bay, conglomerates and sands mostly of light color, are interstratified with layers of trap, often daloidal, and succeeded by beds of trap, largely developed in the pen between Black Bay and Lake Superior, and perhaps belonging in p the next division. (6,000 to 10,000).

12. The great crowning overflow of columnar trap, which caps th from the Pigeon River to the Kaminitiquia, and forms the summit of Th Cape. It is characterized by numerous joints, dividing it into large co at right angles to the plane of the mass. The rock is hard, more coarsely crystalline, and composed principally of varieties of augit feldspar, with magnetic iron.

While different portions of this series were found overlying uncon ably, in some places the Laurentian, and in others the Huronian the additional facts, which have been observed during the past su leave little doubt that the great trap overflow, part of which has bee

Unconformable trap.

tioned as crowning Thunder Cape, rests in different places, som unconformably, upon different members of both the upper and groups of the Upper Copper-bearing series. Sir W. E. Logan has al pointed out a want of conformity between it and the limestone sandstones (9 and 10), and noticed the more horizontal attitude of the lying trap. (*Geology of Canada*, pages 70 and 79.) On the sout of the lower reach of the Kaminitiquia, and in the country south-eas from that river, to the shore of Lake Superior, the trap is found restin the almost horizontal shaly, cherty and jaspery beds, belonging to the part of the series. In 1868, Mr. McKellar observed the gray argill sandstones (4) running under the trap on the north side of Thunder and last season, Mr. Macfarlane detected the higher conformable do sandstones and conglomerate layer (5) also underlying the trap, unconformable contact with it, on Wood's Location on the south side cape. On the west side of Nipigon Harbor, the same columnar seen resting upon indurated red marl, believed to belong to the division of the foregoing list. In the valley of the Black Sturgeon the same trap appears to overlie conformably the almost horizontal stones, red shales and marls; while in the neighborhood of the p from Black Sturgeon Lake to Lake Nipigon, a similar rock is asso with beds of light gray sandstone and dark compact argillite in a v attitude; a great mass of trap of the same character, occurring

igher level, appears as if it might overlie the whole unconformably. Additional details in regard to these rocks, as they occur on Lake Superior nd around Lake Nipigon, will be given further on, but much remains to be one before their sequence is properly worked out.

The age of the Upper Copper-bearing rocks has always been considered s doubtful, and although provisionally classified with the Lower Silurian, ie name which they received was intended merely to distinguish them from ie Huronian, or Lower Copper-bearing series. It has been mentioned by ir W. E. Logan in the *Geology of Canada*, page 85, that the difficulty in etermining their age arises from the absence of fossils of any kind. As, owever, new facts accumulate in regard to them, it becomes probable that ey may now be considered as of Permian and Triassic age. Being of a fferent general lithological character, as shewn in the foregoing list, and uch greater thickness than the Lower Silurian rocks of any contiguous rt of the continent, and being without fossils, which are generally so undant in these rocks, are all facts unfavorable to the supposition of their ing of Silurian age; while the prevalence of such great volumes of marls d sandstones charged with the red oxide of iron, and of great overflows basalts, amygdaloidal and other trap rocks, the peculiar composition of e dolomitic sandstones, together with the presence of various zeolites and tive copper, and the existence of brine springs, cause them to bear a ong resemblance to the rocks of Permian or Triassic age in Nova Scotia. Age of Upper rocks.

THE THUNDER BAY REGION FROM PIGEON RIVER TO BLACK BAY.

The shore of Lake Superior, from the boundary line at Pigeon River to e mouth of the Kaminitiquia, is overlooked by bold cliffs, coming se to the lake, and rising to a height of from 500 to 1000 feet above its el. This part of the coast, as pointed out in the *Geology of Canada*, 77, is occupied by the shales of the lower group, while the higher hills are capped by the great basaltic trap overflow, which, as already mentioned, pears to constitute the newest member of the whole series. The same ks seem to occupy the entire area northward to the Whitefish Lake and ver, where they terminate in bluffs facing the north-west, similar to those ich face to the south-east on the shore of Lake Superior. A correspond- arrangement marks the northern boundary of this area, where, to the south the Kaminitiquia, below the mouth of the Whitefish River, and nearly responding with the southern boundary of the townships of Neebing l Paipoonge, high north-facing bluffs of trap, resting upon the lower mbers of the series, overlook the valley of the river. The shales and ociated rocks, which crop out at a low angle from beneath the trap, tinue, however to the north side of the lower stretch of the river. Rocks of the shore.

Their northern boundary would be roughly indicated by a line drawn fr the Grand Falls, to a point on the shore of Thunder Bay, about six mi east of the mouth of the Current River.

As pointed out in the *Geology of Canada*, p. 67, the lower members the formation, which underlie the trap in this region, consist, in ascendi order, principally of conglomerates, chert beds, hard shales of a blui black color, with some dolomite layers, and sandstones. Interstratif beds of more or less crystalline dark colored trap also occur in seve parts, particularly towards the bottom of the series, and dykes of the sa rock are common. The whole formation has a general dip, at a v

Jasper rocks.

low angle, to the south-eastward, or towards the lake. The darkly colo cherty and jaspery beds are often finely mottled with darker and ligh shades of green and spots of black and red. Sir W. E. Logan has refer to the occurrence of pebbles of this character on the shores of Thun Bay. The rock was found in place on the flanks of Rabbit Mount in the township of Paipoonge, three miles south of the Kaminitiquia Riv Bands of reddish jasper were found in the slates on the opposite side the river, at about the same distance from it. The occurrence of upwa of one hundred feet of the dark hard argillaceous shales, lying nea horizontally at the Grand Falls of the Kaminitiquia River, is noticed the *Geology of Canada*, page 68. Similar rock was found *in situ*, several places on the river below the falls, the lowest being on lot range A., about six miles from its mouth. It was also traced for two three miles up the bed of the Slate River, which enters the Kaminitiq on the south side, near the east town-line of Paipoonge.

A trap dyke, curiously weathered, and standing up conspicuously of the shale, crosses the stream about half a mile above its mouth. bed of the Whitefish River is much encumbered with boulders, but shales are seen here and there in the lower part of its course. At al twelve miles south-west of Fort William, and two or three miles north- of the shore of Lake Superior, opposite Pie Island, a lake occurs, ca Ka-zee-zee-kitchi-wa-ga-mog, which was surveyed by Mr. W. W. Rus of our party. It was found to be seven and a-half miles long, north-east and south-west course, and one mile wide in the middle, surrounded with high bluffs of trap, like that crowning McKay's Mount Its surface has an elevation of several hundred feet above Lake Supe and Sucker Brook, which discharges its waters into the lake, rushes d over the underlying almost horizontal shales. These contain numbe singular spheroidal concretions, similar to those observed by Sir W Logan in the shales of the same formation, in the bed of the Kami quia.

A river entering Lake Superior, between Pine River and Su

3rook, called by Mr. McKellar Cloud River, was followed by him to Cloud Lake, a distance of about six miles from its mouth. He found the hales and associated rocks of the lower group all along the bed of the tream, while the tops of the hills were composed of the trap of the crowning verflow. The whole of the district between this part of the north-west shore Cloud River. f Lake Superior, and the Whitefish Lake and River, is described as very roken, with numerous lakes surrounded by bluffs of trap. Whitefish River, hich was found to be unfit for canoeing, except for a mile or two from its outh, does not flow from the lake of the same name. Its upward course described as curving round to the northward at about twelve miles from s mouth. Whitefish Lake is about seven miles long from east to west, nd about two miles wide. High trap bluffs are said to overlook it on the outh side. Proceeding westward, shales, similar to those of the lower part f the Kaminitiquia, are reported as occurring between Arrow and Gun-int Lakes, and a specimen of the dark variegated jasper of this series, icked up on the shore of the latter lake, where it was said to exist *in situ*, as given me by a gentleman who had just come through it in a canoe. he south shore of the lake is said to be steep, and it is probable that the reat trap overflow extends thus far. The Upper Copper-bearing rocks ould appear to terminate at the west end of Gun-flint Lake.

The stratified rocks, both of the mainland and the islands from Pigeon iver to the Kaminitiquia, and from Thunder Bay for a considerable stance eastward, are cut by innumerable trap dykes of all sizes, running rallel to each other, in a northeasterly course. They, therefore, form slight angle with the general direction of the shore, it having a more rtherly trend.

The Hudson Bay Company's winter trail from Fort William to Bass- Selkirk's road. ood Lake, follows the Whitefish River, Lake, and Portage, in going from e Kaminitiquia to Arrow Lake, but this route is impracticable for canoes. any years ago, Lord Selkirk had a waggon-road opened from the Pares-ux Rapids on the Kaminitiquia, to Whitefish Lake, which was used as a mmer route, in connection with the boundary-line chain of lakes. The valley the Kaminitiquia, from the mouth of the river to the junction of the hitefish, a distance of about twenty miles, is covered with yellowish sand d loam, underlaid, in the lower levels, by bluish-grey clay. The breadth these alluvial deposits from north to south, on the dividing line between eebing and Paipoonge, is about seven miles, and it is apparently greater re, than either above or below. The soil does not appear to be fertile, cept close to the river, and towards the mountains on the south side, ere hard maple occurs in groves, which are used by the Indians for gar-making.

North of this alluvial tract, at the south-west corner of mining-lot 1,

Herrick's survey, three-fourths of a mile north of the town-line of Neebin nearly horizontal calcareous beds occur, containing small coral-li silicious concretions and vertical cylinders of chalcedony, transverse sectio of which shew fine concentric rings resembling agate. Beds of dolomi are seen about the north end of lot 3, of the same survey. Sandston containing magnetic iron, is found on lots 1, 2 and 3, Herrick's surve On the northern part of mining-lot 54, adjoining the last, black silicio shales occur, which, with the other strata in the neighborhood, ha a slight dip to the eastward. An exposure of trap, supposed to be a dyk appears in a swamp on mining-lot 55, between lot 3 and the north line Neebing. At a place called the Algoma Mine, on the north-west corn lot (25 in the 5th range north) of Neebing, there is an outcrop of thin

Iron ore.

bedded, flaggy, hard, dark grey sandstone, largely composed of particles magnetic iron, and weathering to a rusty color. A brook, with a perpe dicular fall of fifteen feet, has here cut a channel through the rocks, a exposed about twenty feet of the beds, which lie almost horizontally, or d very slightly to the north. A specimen, which appeared to represent t greater part of the mass, has been found by Mr. Broome, the chemi assistant to the Geological Survey, to contain 37.73 per cent. of metal iron, so that the rock may be considered an iron ore. Three veins, one them thirty-one feet in width, and holding galena, occur here. Thes with the iron-sandstone, will be more fully described under the head Economic Minerals. The same highly ferruginous sandstone, dipping ve slightly east-north-east, is again exposed on the banks of a brook mining-lot B, rather more than a mile north-east of the Algoma Mine.

Copper ore.

On mining-lot C, about two miles north-east of the Algoma Mine, a ve which contains copper pyrites, and will be again referred to, cuts t same sandstone, which here has a horizontal attitude. At a mile from t locality, in a course bearing N. 35° E., and about the south end mining-lot G, there is a north-east facing bluff, thirty feet high, co posed of similar sandstone, having a slight dip to the south-westwa Following the same course, at half a mile from this locality, there occu on mining-lot H, an exposure, fifty feet wide of dark compact, fi grained trap, running S. 75° W., (mag.), but whether belonging to dyke or a bed could not be determined ; and at about one mile, on minin lot J, a south-facing cliff, of similar trap, about twenty feet high. Furt on, another south-facing cliff of trap occurs, at three hundred and fi yards from the last ; and at half a mile, a high north-facing bluff of the sa rock is met with on the north ends of lots J and K, running N. 7 E. (mag). About a mile to the east, on mining-lot L, this bluff swee around, and forms the termination of a ridge pointing to the east-north-ea which is seen conspicuously from Thunder Bay. The upper fifty feet

nore, at the termination of this ridge, consist of trap, but the black shales ıppear to run below it, in which case, it would belong to a bed interstra-ified with the sedimentary strata of the group under consideration.

On the east side of the Current River, three ridges, composed of similarly nterstratified trap, each having a north-easterly course, are met with on he Thunder Bay Mining Company's location, and the lots adjoining it on he east, and a fourth runs in the same direction across the southern part of he Shuniah Mining Company's location. From Bare Point on the ormer location, a ridge of trap runs almost due west a considerable dis-ance, and may also be an interstratified mass. The surface of the trap, n the south side of the point, dips south, at an angle of 20° to 25°, and he black shales are found on each side, close to it. The trap which is net with at the commencement of the Red River Road occurs in a imilar manner. Along the north shore, from Bare Point, eastward the head of Thunder Bay, a distance of twenty miles, nearly all the lands, including Kitchi-minis, or Big Island, and the extremities of lmost all the points, are composed of trap, associated with the shales, and most cases, resting upon the lower portion of the group. The Welcome slands, opposite the mouth of the Kaministiquia, and four miles from it, are omposed of the grey argillaceous sandstones of the lower group, and trap, pparently belonging to dykes. Trappean rocks.

On the Kaminitiquia River, as indicated in the *Geology of Canada* age 68, the shales of this group come in contact with the older rocks, bout one-third of a mile above the Grand Falls. In tracing eastward the ne which marks the southern boundary of the Laurentian and Huronian ocks, it is found, after a few miles, to make a bay to the north, crossing ie Red River Road, about ten miles from Thunder Bay, returning to it four and a quarter, and recrossing again at three and a quarter miles. he interval is occupied by the thinly bedded black chert, hard dark shales, eathering black, and some arenaceous and conglomerate beds, which lie most horizontally where they come up against the gneiss. On the bank McIntyre's River, on mining-lot M, there is an exposure of arenaceous ds and dark slates, like those at the Grand Falls of the Kaminitiquia, l weathering to an iron-black. Some of the beds here are composed small black hard rounded grains, in a white apparently silicious ment. The strata dip north 40° west (mag.) $<15°$, and have a thick-ss, in the exposed section, of one hundred feet or more. A brecciated in, forty feet wide, which will be again mentioned, crosses the river this lot. From the point where it intersects the road, at three and a arter miles from Thunder Bay, the boundary of the gneiss runs north-stward to the Current River, which it crosses on mining-lot S. At this ace, the Laurentian rocks appear to be confined to a narrow breadth on Boundary of Laurentian and Huronian.

the river, and to be flanked by the black shales on the south, and by t dioritic slates of the Huronian formation on the north.

Limit of Copper-bearing rocks,

From the intersection of Current River, the southern boundary of t older formations runs about due east, coming to the shore of Thunder B near Goose Point, seven miles from the mouth of the river. Continui eastward, it cuts off all the points, (the metamorphic rocks being seen the bottoms of the coves), along the north coast of Thunder Bay, to with four miles of its head, where it strikes inland, with a north-easterly bearir Between the Current River and the head of the bay, the Upper Copp bearing rocks repose, in some places, upon the Laurentian, and in oth upon the Huronian series. At the Thunder Bay Mine, one of the thi beds of trap, already referred to, is underlaid by about fifteen or twe feet of alternating beds of dark shale, impure dolomite, argillite, and wh appear to be diorite layers. These are followed, in descending order, massive dark olive and drab-grey argillaceous slate, about fifty-five feet which have been cut in the shafts, the whole lying almost horizontal An exposure of dolomite occurs about a quarter of a mile north-east the mine, which is two and a half miles north-east of the mouth of Curr River, and one mile north-west of the shore of Thunder Bay.

Laurentian and Huronian systems.

Laurentian.

Northward from the limit of the Upper Copper-bearing rocks, which just been defined, between the Grand Falls of the Kaminitiquia and head of Thunder Bay, the country is occupied partly by Laurentian a partly by Huronian rocks, to a distance of about eight miles from former, and about sixteen from the latter. The distribution of the t formations is represented, as accurately as possible from present data, u the accompanying plan. North of this area is the country around Dog La which is all Laurentian, so far as known. The gneiss of the Dog La region is remarkable for being distinctly stratified, and containing mu mica, while that of the outliers to the south is very massive, and genera rather of the character of syenite and granite. The Huronian rocks this region consist of slates, some of them dark green and composed hornblende, some greyish-green and dioritic; others are light-colored, fi grained, quartzose, somewhat nacreous micaceous schists; while diori slate-conglomerates, quartzites, fine-grained felsites, massive diori ribboned jasper and iron ore, also occur.

Dog Lake.

Dog Lake is of an irregular V-shape, the apex, at which the ou occurs, being pointed to the south-west. From the outlet, one arm stretc north-eastward fifteen miles, while the other extends east eighteen mi The breadth of the body of the lake, between the junction of the two a

and the outlet, is from two to four miles. From the eastern extremity of he lake, the general strike of the gneiss is westward, with the course of he longer arm, gradually curving round, till at the outlet it becomes outh-west. Following down the Kaminitiquia River, from the outlet of Dog Lake to near the junction of the Mattawa River, where the gneiss erminates, the strike continues to curve a round from south-west to south, nd finally to south-south-east. On the south shore of Dog Lake, about ne mile east of the Little Dog Portage, the gneiss, which is coarse-grained, and reddish, is full of irregular branching veins, (some of them a oot thick) of flesh-colored feldspar in large crystals. They run mostly vith the stratification, which is here on edge, and striking S. 75° to 80° W. mag.). In the neighborhood of the outlet, and along the Kaminitiquia River, to Little Dog Lake, the rock is principally mica schist. Laurentian gneiss.

Three miles below the head of Little Dog Lake, the gneiss dips N. W. t an angle of 70°. At the first portage, which is about three and a quarter niles below the same point, gneiss of a greyish and reddish color occurs, ssociated with mica-schist holding garnets. The strata, which are on dge, strike S., from 5° to 10° E., and are overlaid, unconformably, by mass of rather fine-grained, dark reddish-grey syenitic granite, con-aining greenish and yellowish crystals of triclinic felspar. At from three nd a half to four miles below the first portage, reddish gneiss occurs, ipping eastward at an angle of 65° to 75°. The junction of the aurentian rocks and the greenish Huronian slates, occurs on the Kamini-quia River, about a quarter of a mile above the mouth of the Mattawa. ight miles east of the Kaminitiquia, the line between the two formations rosses the Old Dog Lake Trail, at fifteen miles from Thunder Bay. orthward from this point, the trail, for two and one half miles, passes over assive red syenite, studded with large crystals of flesh-colored orthoclase eldspar, which give it the appearance of a very coarse porphyry. It hews no trace of stratification or lamination of any kind, and the feldspar rystals, which measure from one to two inches on the side, have no regu-arity of arrangement. At about eighteen miles from Thunder Bay, the ail crosses a ridge of rather fine-grained reddish-gray granite, composed f about equal parts of quartz, feldspar and mica Between the twenty-mile ation and the southern bay of Dog Lake, which is about twenty-four niles from Thunder Bay, fine-grained micaceous gneiss and mica-schist, unning south, 15° west, (mag.) with a vertical dip, are seen in places n the trail.

As already remarked, between the third and fifth miles the Red iver Road passes over a spur of the Laurentian area, which lies etween it and the Current River. Where it first makes its appear-nce on the road, at about three and a quarter miles from Thunder Bay,

Laurentian rocks.

it consist of very light reddish-gray quartz rock, with a little feldspar, a small specks of black mica. About a mile further on, very dark green silicic slate and hornstone are met with, running N. 70° E. (mag.) and vertic They are associated with a dark green coarse-grained massive ro resembling diorite, and may belong to the Huronian series. About quarter of a mile north of the five-mile post there is a prominent point coarse-grained gray syenitic gneiss, containing large flesh colored crystals feldspar. Thin bands of a black micaceous hornblende rock, and small comp reddish bands, run irregularly east and west in the mass. Dykes of bla trap, which have a zig-zag appearance, owing to numerous small dislo tions, cut it in a north and south course. One of these dykes was obser to enclose patches of the country rock.

The Dog Lake Trail leaves the Red River Road about the seve mile, and soon comes upon the gneiss, which is exposed along it fo breadth of five miles, when the Huronian slates commence. It consists reddish and grayish gneiss, alternating in thick and thin bands, a striking generally at right angles to the road, or about east-north-e and west-south-west; but at about a mile from its northern limit it appe to dip west at an angle of 60°.

At the ten-mile post, on the Red River Road, there is an outcrop massive light reddish-gray syenite, containing more feldspar than quar and conspicuously marked with elongated crystals of black hornblende.

The band of gneiss, already mentioned as occurring on the Current Ri on mining-lot S, as well as another which crosses the same river ab eight miles from its mouth, are believed to be spurs from this area.

Syenite.

Coarse grayish-red syenite occurs between two branches of Current River, ten miles from its mouth, also on the shore of Thunder B near Goose Point, and three miles north of it, and again near the sho for three miles on each side of McKenzie's River. In each of th places it appears to form an outlier, surrounded by the Huron slates. A similar rock was found by Mr. McKellar on the Curr River, at nineteen miles, in a straight line, from its mouth, and main body of the Laurentian gneiss is about one mile farther on. To east of Current River, and at a distance of four or five miles north Thunder Bay, there occurs a range of hills of gneiss and syenite, wh continues eastward to Black Bay. A spur from this range comes upon the west shore of Black Bay, at Granite Point, and a number of sm outliers, surrounded by the red marls of the Upper Copper-bearing seri occur to the south of the range, in the township of McTavish. Gran Island, in Black Bay, is also Laurentian. The rock at all the last me tioned localities is pink, of a granitoid character, composed mainly feldspar and quartz, not coarsely grained, and containing no mica and ve little hornblende.

In ascending the Kaminitiquia, the Laurentian rocks are first seen at bout one-third of a mile above the Grand Falls, where gray quartzose neiss, containing some feldspar, is exposed at the second portage, and is verlaid by hornblendic, passing into dioritic schist, containing actinolite ystals and specks of iron pyrites, and dipping N. 5° W. (mag.) $<$ 60°. breadth of 150 paces of this rock is exposed at the head of the portage. t about four miles above the Falls, grey micaceous gneiss occurs at the ext or third portage. It contains colorless quartz, with white and ellowish crystals of feldspar, and a little hornblende. The rock is of a assive character, and encloses short lenticular patches of mica-schist, nning with the stratification, which dips N. 5° W. (mag.) $<$ 75°

Huronian rocks.

Between the margin of the Upper Copper-bearing rocks, on the north ore of Thunder Bay and the Laurentian range, already described, all e country not occupied by the syenitic areas which have been menoned, appears to be composed of rocks of the Huronian series. These nsist of diorites, dioritic conglomerates, hornblendic and fine-grained icaceous slates, with some quartzites. In ascending the Current River, e first four miles are upon the Upper Copper-bearing rocks, but beyond is, to a distance of about twenty miles in a straight line from its mouth, r. McKellar found nothing but Huronian slates of different kinds, with e exception of the gneiss band, at about eight miles, which has been eady referred to. At the end of this distance he came upon the ıth-east border of the Laurentian area surrounding Dog Lake.

On the old trail from Thunder Bay to Dog Lake, the space between the elfth and fifteenth mile-posts is occupied by Huronian slates. Those on e south side of the interval have a green chloritic appearance, hold ains and cubes of iron pyrites throughout, and irregular patches of red d reddish-gray feldspar in the planes of bedding or cleavage, which is nost vertical, and runs N. 80° W. From thirteen and one-half to foun miles, the rock is a very dark hard greenish clay-slate, apparently on ge, and running generally N. 60° E. At fourteen miles, a band of a newhat arenaceous character occurs, striking N. 65° E. It has been eady mentioned, that in descending the Kaminitiquia River, the gneiss ds, and the Huronian slates begin, at about one-fourth of a mile above junction of the Mattawa. Opposite the mouth of this river, the rock ming the bank of the Kaminitiquia is a fine-grained rather soft dioritic te of greenish and bluish-gray colours. The general strike of the avage or bedding is east and west, varying ten degrees each way, and dip southward, at an angle of about seventy degrees. It is cut by merous short irregular veins or patches and strings of white quartz, ding a little lilac-coloured petalite. The course of these is about 25° E. (mag.) On the tops of the hills, near the south side of

the Mattawa, and about one mile from its mouth, dark green silicious c slate occurs on edge, and runs N. 85° W. Massive and laminated bands, bands of different shades of colour alternate. It contains numer quartzose strings, weathering yellow, also reticulating strings irregular parallel veins and strings of pure quartz. Spots or ker of a lighter colour and more granular character than the rest of the r run in irregular groups through it. The Huronian slates are said to tinue westward, the whole length of the Mattawa River, and along shores of Shebandowan Lake, from which it flows Mr. G. F. Aus P.L.S., informed me that after going a few miles up the river he fo the slates to assume a softer and more talcoid character than they pos at its mouth. A specimen of light-coloured, very fine-grained quartz somewhat nacreous, micaceous schist was brought by Mr. And Bell, P.L.S., and one of dark greenish-grey clay-slate, by Mr. Tho Monro, C.E., of the Public Works Department, from Shebandowan La and the Indians have brought to me specimens of greenish hornblendic dioritic slates from the same lake. In the hills on the left side of

Huronian rocks.

Jasper and iron ore.

Kaminitiquia River, a finely banded rock, made up of jasper and magn iron, occurs at the distance of one mile south-east of the junction of Mattawa. The alternating beds are usually not more than from one- inch to two inches thick, and present a very striking contrast ; the jas being brown or bright red, while the magnetic iron is black, finely gra lar and glistening. The beds are somewhat contorted, but their gen strike appears to be about east and west. On the west side of the Ka nitiquia River, at about a mile and a-half below the Mattawa, the s ribboned jasper and iron-ore rock occurs, associated with black ar ceous layers, semi-translucent banded chert, approaching chalced and dark fine-grained hard ribboned argillite or felsite, having a choidal fracture. These strata are considerably contorted, and dip at l angles, but their general course appears to be north-westward. On hig ground, overlooking the river at this locality, and possibly unconform to the strata just described, are thick beds of fine-grained greenish-g diorite, mottled with small light red patches, with others of a greenish-g diorite, coarsely porphyritic from the presence of numerous crystals greenish feldspar. The beds vary from one foot in thickness, up to fift or twenty feet, and strike N. 65° W. (mag.), with an inclination to north-eastward of about 75°. Following the river downward, the d green hornblendic, and lighter fine-grained mica-slates are observ wherever the rock is exposed, as far as the band of gneiss, which has b already mentioned as occuring at about four miles above the Grand F The dip is northward, at angles varying from 50° to 70°. At a sh portage, about a mile above the place where the gneiss occurs, there

and of slate of a rather lighter colour than usual, and weathering yellow, Huronian rocks. rom the presence of numerous grains of iron pyrites. It also holds grains f clear quartz, about half the size of peas, and in the cleavage planes, cales of silvery mica. In the *Geology of Canada*, (page 65) it is entioned that in this part of the river some very large boulders with a rownish or blackish matrix, having much of the trappean aspect belonging some of the varieties of the slate-conglomerate, and holding blood-red sper pebbles and balls of iron pyrites, have been observed, resting upon e green slates, and apparently not very far removed from the parent ck.

Strawberry Brook joins the Kaminitiquia on the east side, about half-a-ile below the Mattawa. The lower reaches of these two streams, entering om opposite sides, lie almost in the same line, and appear to run on the me belt of rock. Following the Red River Road from the Kaminitiquia wards Thunder Bay, the green Huronian slates are the only rocks seen within ten and one-half miles of the latter, where the red syenite, ready mentioned, is met with. At thirteen and one-half miles, the een slate holds numerous specks of iron pyrites, and is cut by a north d south trap dyke, about five feet wide. In the neighbourhood of the even-mile post, similar slates, holding strings of quartz, are thickly otted with white grains. The strike is here about north and south, parently conforming with the western side of the gneiss area already ferred to, between this road and Current River.

THE PENINSULA BETWEEN THUNDER BAY AND BLACK BAY

occupied entirely by the rocks of the Upper Copper-bearing series. The orthern limit of the formation would be approximately marked by draw-g a line from a point six miles north of the extremity of Thunder Bay, stward to Granite Point on Black Bay. The lower group, comprising e chert bands, shales and argillaceous sandstones, is found near the ater's edge, all along the south-east shore of Thunder Bay, from its head Thunder Cape. From the head of the bay, these rocks extend inland Silver Lake, a small sheet of water at a distance of four miles, in a rtherly course, from the shore. In approaching the Cape, and when within out six miles of its extremity, the line marking the summit of the lower oup sweeps round and comes to its south side, near Ryanton, which is tuated about the middle of Wood's Location. On Thunder Cape, a cliff, ree miles long, rises to a height of 1,350 feet above the water, and forms e most conspicuous headland on Lake Superior. The upper part of the iff is composed of the columnar trap of the crowning overflow (12.) It is a dark color and crystalline. Mr. Macfarlane has observed that the

coarsely grained varieties prevail towards the summit, and those of a fi texture near the contact with the underlying strata; and a similar f

Trappean rocks. was noticed by myself in the Nipigon country. This trap is composed grayish and greenish feldspar and hypersthene, with a little hornblende a magnetic iron. According to Mr. Macfarlane, the rock would be cal hyperite. (*Canadian Naturalist*, new series, vol. IV, page 460.) T argillaceous sandstone beds, which underlie the greater part of the trap the cliff, are almost horizontal, but still their surface appears to have b denuded or disturbed before the trap was laid upon it; and on the w ern part of Wood's location, where the eastern termination of the occurs, Mr. Macfarlane found a distinct want of conformity between great trap overflow and the underlying conglomerates and dolomitic sa stones (5), which rest conformably upon the argillaceous sandstones. T light gray dolomitic sandstones (6) sweep round from the shore of La Superior, on the eastern part of Wood's Location, to a point on the south-w side of Thunder Bay, about six miles from Thunder Cape, from which th continue north-eastward, forming a conspicuous cliff close to the shore the bay, all the way to its extremity, and beyond it to Silver Lake. No of this lake, they are again found on the south side of the Laurentian ran The red sandstones and shales, interstratified with whitish sandstones a conglomerate layers (7), and the indurated red and yellowish-gr calcareous marls (9) run longitudinally, with a breadth of from two to f miles, through the whole length of the peninsula; and in the township McTavish, they appear to spread out all along the south flank of the La rentian range from Silver Lake to Granite Point, a distance of about ele miles. In this interval, numerous spurs and outliers of the syen protrude through the red marls. The compact light reddish limesto (8), which come between the two last mentioned sets of rocks, and wh may prove valuable for burning into quick-lime, occur on the shore of La Superior in the vicinity of the eastern side of Wood's Location. T white and the red argillaceous sandstones with conglomerate layers (1 occupy the western side of Black Bay, from its entrance to McEachra Point in the township of McTavish, and may extend inland, in some plac to a distance of two miles. Several lakes occurring on this peninsu which have not hitherto been represented on the maps, are shown on accompanying plan. We are indebted principally to Mr. P. McKel for these new geographical features. The lake entering Wood's Locati but lying principally to the north of it, is estimated by Mr. Hugh Wils P.L.S., to be six miles long and three miles wide. The small lake Thunder Cape has an elevation of several hundred feet above La Superior.

BLACK STURGEON RIVER.

The country around the head of Black Bay, and across to Nipigon Bay, low and level. The general upward course of the Black Sturgeon River, hich enters the northern extremity of the former bay, sweeps round in a gular curve from north to north-west, and at the end of forty-four miles aches Black Sturgeon Lake. This lake may be described as lying to e side of the general course of the river, the upper section entering the uthern extremity of the lake only one mile and three-quarters west of the int where the lower section discharges from it. The upper section of the ver, in ascending from the lake, is found to have, at first, a very tortuous urse, with low land on each side. At three or four miles south-west of the int at which it enters Black Sturgeon Lake, it divides into two branches, following either of which, we pass through a lake; Pike Lake on the re southerly branch being about two miles across, and Cyclas Lake on the ier, about one mile. At about fifteen miles from Black Sturgeon Lake, e southern branch enters a hilly country, and the northern branch at out thirteen miles; but east of this range, the whole tract through ich the two branches pass is comparatively level, and the country con-ues so to Black Sturgeon Lake and the lower section of the river. The ward course of the south fork of the river just mentioned, extends th-westward in two principal branches (each proceeding from lakes) to listance of about thirty miles beyond the point at which it enters the ly country; so that the whole length of the general course of the river uld be about ninety miles, but following its windings, about double that tance. Black Sturgeon Lake stretches in a north-westerly direction. It asures two miles in width by thirteen in length, and comes within about e mile of the southern arm of Black Sturgeon Bay on Lake Nipigon. A ley, paved with rounded boulders, extends from one to the other. The lakes appear to have nearly the same level. I was informed by an Indian that, in former times, whenever the water happened to be high, a ll quantity flowed from Lake Nipigon into Black Sturgeon Lake, but that iad altogether ceased to do so for the last thirty-five years. The water Black Sturgeon Lake and River is very dark, while that of Lake Nipigon emarkably clear. A small brook enters the south arm of Black Sturgeon y, and its dark-colored water fills the arm northward to the open bay, ere it mingles with the clear waters of Lake Nipigon, which could not pen if the water flowed from this arm into Black Sturgeon Lake. A pond, quarter of a mile long, occurs on the portage, and it is just possible that ttle water may find its way, under the boulders, from Lake Nipigon to ck Sturgeon Lake; but, if so, the quantity must be very small, as the ck Sturgeon River appears to be as large where it enters as where it ves the lake, although several large brooks fall into the latter on either

Geographical details.

side, and appear to be quite sufficient to compensate for the evaporati
A well marked water-line, three feet over the summer level of 1869,
observed on the rocks in many places around the shores of Lake Nipig
The Indians say that previous to thirty-five years ago, the water had st
for a long time at this height, and that it then gradually fell for seve
years, until it reached its present level. Leaving Black Sturgeon La
Black Sturgeon River. the river of the same name runs nearly straight, in a south-easterly cou
and is very rapid for six miles and a-half, when it enters Nonwatan La
This picturesque sheet of water is three and a-half miles long, from no
to south, and one mile and a-half wide in the middle. It receives a c
siderable stream called Nonwatan River, from the westward, the upw
course of which lies south-westward for a considerable distance, thro
a level country. Leaving this lake, the Black Sturgeon River flows sl
gishly between marshy borders for the distance of a mile, to L
Nonwatanose (or Little Nonwatan), one mile in diameter and nearly rou
At two miles and three-quarters below this lake, we come to Esh-q
nonwatan Lake, two miles in length, and the last one on the river.

It has been mentioned that a level tract of land occurs on the west s
of Black Sturgeon Lake, and along the upper section of the Black Sturg
River. This continues down the western side of the lower section
distance of about three miles below the last lake, from which point
river, for a distance of fifteen miles, is approached, at intervals, on eit
side by high hills, leaving a valley of perhaps three or four miles in wi
between them. Below this, the country again becomes level to Black
on Lake Superior.

From the last lake, the river is extremely crooked all the way t
mouth. It is interrupted by numerous short rapids, mostly over bould
between which the current is slack, with deep water and a muddy bott
The banks are composed of fine sandy clay, and vary from four to f
feet in height. Descending from Black Sturgeon Lake, our larger can
manned by white men, ran all the rapids in the river, excepting one
which there is a slight perpendicular pitch. The river is observed
increase rapidly in volume all the way from Black Sturgeon Lake to
mouth, where it has become one of the largest rivers entering Lake S
rior. The principal tributaries join it from the west side, the cou
between this river and the Nipigon not being of sufficient breadth to af
large streams, and such as do exist between the two rivers fall mostly
the latter. The largest of these western branches falls into the Bl
Sturgeon River at about fifteen miles from its mouth.

Geological description.

Lower Section. High hills approach the Black Sturgeon River u
the west side, beginning to the southward at a point about eight miles f

e mouth, and continuing at distances varying from less than one mile to ore than three miles from its banks, to within two or three miles of the west lake. Those nearest to Black Bay have an elevation of about a ousand feet, but the height diminishes very much in receding from Lake iperior. These hills appear to be composed principally of the reddish ndstones, shales, and indurated marls of the Upper Copper-bearing series, ing almost horizontally, and capped by an overflow of columnar trap of rying thickness. The rocks exposed all along the bed of the lower secon of the river, from Black Sturgeon Lake to the mouth, belong, with a w exceptions, to the same series, being principally indurated marls and ndstones. Black trap occurs at the first rapid, one mile and a quarter low the lake, but from this point downward, indurated red marls, with ght greenish layers, all lying nearly horizontally, are beautifully exposed ong the banks of the river to Nonwatan Lake. At three miles below sh-qua-nonwatan there is an exposure of dark brownish fine-grained mpact felsite, ribboned with lines and patches of reddish and others of eenish color. It dips at a low angle, southward, and resembles some the beds associated with the Upper Copper-bearing series in the Thunder ty region, but may be Huronian. An exposure of trap is met with in e bank of the river, just above the main west branch, at about fifteen miles om the mouth, and another at about eight miles from the same point. fixed rock was observed along the south-west side of Black Sturgeon ke, except near its head, where black trap occurs on both sides, and conues down the north-eastern shore for seven or eight miles, when Laurenn gneiss is met with. From this point, a considerable area of gneiss etches along the north-east side of the lake, towards the outlet. High hills trap rise on the east side of Nonwatan Lake, and continue southward, with ore or less regularity, for a distance of about sixteen miles, or to within enty miles of Black Bay. At about sixteen miles from this bay, the hills the east side are composed of greenish slates, supposed to be Huronian, iking about N. 70° E., and dipping at a high angle to the northward. om this locality, hills of reddish Laurentian gneiss run close to the river, a continuous range, varying from five to seven or eight hundred feet in ight, for a distance of about six miles towards its mouth. These hills rm part of the western boundary of a Laurentian area, extending to the ipigon, and which will be described in connection with that river.

Upper Copper rocks.

Upper Section. No solid rock appears at the southern end of Black urgeon Lake, but pebbles of indurated red marl and impure limestone are undant on the beach. The black trap occurs at the first rapid on the north anch of the upper section of the river, about six miles south-west of the ke. At the head of this little rapid, a brine spring is found on the north nk of the river. It rises among loose masses of the trap, in the imme-

Brine spring.

diate vicinity of the same rock *in situ*. Angular fragments of indura red arenaceous marl, some of them having light spots, were also comı in the neighborhood, and it is probable that the brine proceeds from st of this nature underlying the trap. Small ridges of the latter rock w crossed, here and there, in making two traverses between the north south branches. It has been mentioned that a range of hills crosses northern branch at about thirteen, and the southern at about fifteen m from Black Sturgeon Lake. This range appears to run south-eastw for a considerable distance towards Black Bay. Its eastern flank is c posed of dark coarsely crystalline trap. Just behind the east slop the range, and between the two branches of the river, a small lake is with, at which, I was informed by the Indians, pipestone, like that of Rock, (a light-red argillaceous limestone) occurs *in situ*. The shingl the bed of the south branch, for several miles east of the trap range, sist principally of fragments of indurated calcareous marls and shale various colors.

NIPIGON RIVER.

The Nipigon River empties into the head of Nipigon Bay, which is most northern point of Lake Superior. It is the largest river flowing the lake, and differs from all the others in having clear water. The owing appears to be about the order, in size, of the twelve largest riv entering Lake Superior, judging principally by the area which each app to drain: Nipigon, Kaminitiquia, Black Sturgeon, St. Louis (in U. Pic, Michipicoten, Goulais, Batchawana, Black, Ontonagon (in U. Montreal, and Current. The character of the Nipigon River and its together with the fact of its draining the largest area tributary to L

Geographical details.

Superior, and connecting this with a lake of such an extent as Nipigon, e tle it to be considered as the continuation of the St. Lawrence beyond L Superior. The general upward course of the Nipigon is due no (astronomically) its mouth and the exit from Lake Nipigon being in al the same longitude. Between these points, however, which are thirty-

Four lakes.

miles apart, the river makes a slight curve to the westward. Four la occur in its course, to which, in the absence of any other names, we g those which are shewn on the accompanying map. The lowest of th Lake Helen, is only one mile from Red Rock, a Hudson Bay Compa post at the head of Nipigon Harbor. At the outlet of this lake the ri is very narrow, apparently only about 100 yards wide, and sweeps aro with a strong current (estimated by Admiral Bayfield at four and one- knots an hour) for a distance of about half-a-mile, between banks of b der-drift, from thirty to forty feet high. Lake Helen, which runs due n

s about eight miles long and one mile wide. The upward course of the river eaves the west side of this lake nearly at right angles to the shore. For six iiles from this point, in a north-westerly direction, it has a width of about ve chains, with deep water, and a moderately strong current, flowing in bed of alluvial sandy clay, with Laurentian gneiss close to the east side, ometimes approaching quite to the brink of the river; while on the west side, ie same rock comes to the water towards the end of this stretch. Here ie river makes a sharp bend to the right, and is broken by a slight chute at 'amp Alexander. At one-quarter of a mile above this point the Long apids begin, and continue for two miles; but in ascending the river they re avoided by turning into a brook on the west side, and following it for about iree quarters of a mile, and from it a portage of one mile and a-half rings us to the foot of Lake Jessie. This lake, which is three miles long, nd studded with islands, is separated from Lake Maria, immediately above , and two and one-half miles in length, by The Narrows, six or eight chains ide, in which there is a strong current, with a fall of six inches or more.

Lakes and portages.

A very high west-facing cliff of columnar trap approaches the river from ie south-westward, at the head of Lake Maria, and runs from this point, a tolerably straight course, all along the east side of the river to Lake Nipigon. Trap cliffs also occur on the west side of the river from Lake Iaria to Cedar Portage, the distance being two miles. This portage is 50 yards long. A mile and a-quarter above it there is another portage, f fifty yards, over an island in the middle of the river. Three quarters of mile above Island Portage, the One-Mile Portage, (2600 paces) begins. t rather more than one mile from the head of this portage the river reaks in a white foaming chute, across a narrow ridge of trap, which eparates Lake Emma from the lower level. A narrow arm, in continuaion of the course of the river, just below White Chute, and parallel with he east shore of Lake Emma, but on a lower level, extends beyond the hute to a distance of about a mile, where a portage of 230 yards is iade across the low trap ridge to the lake which has just been mentioned. 'his lake is nearly four miles long. Between it and the point at which the iver leaves Lake Nipigon, a distance of some six miles, four principal rapids ccur, the lowest of which is seen where the river enters the northern xtremity of Lake Emma. The canoe route turns aside from the waters f the Nipigon at the north-west angle of this lake, and for one-quarter of mile follows a brook flowing from Lake Hannah, which has a slightly igher level than the last lake. Four miles more, in a north-westerly ourse, brings us to the head of Lake Hannah, from which Flat Rock Porage, about one mile in length, carries us to the shore of Lake Nipigon.

The following list shews approximately the levels in ascending the river, nd the height of Lake Nipigon above Lake Superior. The three princi-

Levels.

pal ascents, namely, at the Long, the One-Mile, and the Flat Rock Porta were determined by observations with two aneroid barometers; the oth were estimated as carefully as possible, on the ground.

	F
Current between Red Rock and Lake Helen........................	
Current in river from Lake Helen to Camp Alexander, six miles, at one foot per mile..	
Chute at Camp Alexander..	
From the last to foot of Long Portage, by way of Portage Brook..........	
Rapids at Long Portage..	1
Current in The Narrows, between Lakes Jessie and Maria................	
Current from last lake to Cedar Portage................................	
Cedar Chute..	
Current from Cedar Chute to Island Chute..............................	
Island Chute..	
Current from the Island to the One-Mile Portage........................	
Rapids at One-Mile Portage..	
Current from One-Mile Portage to White Chute..........................	
White Chute..	
Current in brook between Lakes Emma and Hannah........................	
Rise from last lake to Lake Nipigon, (Flat Rock Portage)................	
Lake Nipigon above Lake Superior......................................	3

Geological description.

Red marls and trap.

From a cove on the west side of Nipigon Bay, about four miles sout Red Rock, a belt of level sandy ground, which is swampy in some pla runs westward to the Black Sturgeon River. Hills of columnar t resting upon the indurated red marls and associated rocks, rise both to north and south of this level tract, near Nipigon Bay, but they do not ext far westward. Near the Black Sturgeon River an isolated hill rises f the level ground. On the sides of this hill the red marls are freque exposed, while the summit appears to be composed of trap. The hill gneiss, which have been mentioned as running down the east side of Black Sturgeon River, terminate at about ten miles from its mouth. F this point the southern limit of the Laurentian area runs northeastwar within about a mile of Red Rock, where the black trap is found res upon horizontal beds of a gray shaly arenaceous rock. On the west of the Nipigon the hills of gneiss approach the river between Lake He and Camp Alexander, and continue northward for some miles along west side of Portage Brook, which joins the river on the lower side of Long Portage. The whole country, from this section of the Nipigon Ri south-westward to the Black Sturgeon, as far as it is known, is compo of Laurentian gneiss, in a succession of high ridges, the depressions betw them being generally occupied by long ponds or marshes.

On the east side of the river, in ascending from Lake Helen, the gneiss Gneiss.
t first dips northward at an angle of about 70°, but soon changes to the pposite direction, the synclinal axis being about two miles from the lake. 3eyond this the dip is uniformly northward, at high angles. The trap egins at Camp Alexander, and continues up the west side of the river, nd of Lake Jessie, while gneiss, with a north-eastward dip, occupies the astern side of the lake. At the head of the Long Rapids the trap, which seen resting upon the gneiss, is close-grained and compact, while irther away, on the east bank of the Portage Brook, it is of a coarser texture, nd thickly spotted with crystals of whitish feldspar. The land is low on ie western sides of Lakes Jessie and Maria, but somewhat hilly to the ast of them. Gneiss occurs at the Narrows, between these two lakes; and a the east shore of Lake Maria, a short distance northward, there is a Mica schist.
onsiderable display of mica-schist, dipping N. 10° E. $<$ 45°. Overlying iis, at the north-east side of the lake, and just under the high trap bluff lready referred to, there is a great thickness of quartzite, probably Huro-ian, dipping N. 20° E. (mag.) $<$ about 80°. Above this lake the river asses for two miles through a gorge in the trap. Mica-schist, holding an bundance of garnets, and running N. 50° E. (mag.), begins at Island Por-ige, one mile and a-quarter farther up, and continues to the One-Mile 'ortage, beyond which the black trap was the only rock seen *in situ* to the iore of Lake Nipigon, following the canoe route by the Flat Rock Por-ige. At the north-west end of Lake Hannah angular fragments of a hard oarse-grained gray sandstone are abundant, shewing that the parent rock not far distant.

LAKE NIPIGON AND THE SURROUNDING COUNTRY.

Nipigon, the name by which the lake is commonly known, is a contrac-on of an Indian word signifying "Deep Clear-water Lake." Our plan f operations in making the survey has been already explained. The eneral outline of the lake we found to be elliptical, the longer diameter Lake Nipigon.
ying a little west of north, and measuring about seventy miles, while its readth is about fifty miles. The shore is, however, deeply indented by irge bays, especially on the south side. Ombabika Bay, on the north-ast side, is the largest in the northern part of the lake, being nearly twenty niles long, with an entrance only one mile wide. These indentations add reatly to the length of the coast-line, which measures 580 miles, without ollowing the smaller bays and coves. This circumstance will, no doubt, e of much advantage in colonizing the land surrounding the lake, since t renders so much of it accessible from the water.

Lake Nipigon.

Nipigon differs from the other great lakes in being thickly studded wi islands, adding much to the beauty of the landscape. It has been alrea mentioned that in the course of our survey we ascertained the size a position of about 460 of the islands, and located approximately about 1 more. These vary in size from eight miles, in their principal diamete down to a few chains in length, but the numbers stated do not include a mere rocks, destitute of trees. Many islands, at a long distance fr shore, could not even be located. Probably the whole number in the la exceeds a thousand. Four of the largest islands range from five to eig miles in diameter, while others, measuring between two and three mil are numerous.

The Nipigon River, which issues from the south-east side, is the o outlet of the lake. I have referred to the fact that, many years ag according to the Indians, a small quantity of the water escaped into Bla Sturgeon Lake. From our observations along this river, it would appe as already stated, that the surface of the lake is about 313 feet over La Superior. The shores are generally bolder, and the water deeper on t southern and western sides than on the northern and eastern, where lo sand-beaches and shallow bays are of frequent occurrence. Mr. Willi Armstrong, of Toronto, who visited Lake Nipigon in 1867, states that cl to Echo Rock, a line 540 feet long was lowered without reaching t bottom. Although we did not actually ascertain the depth anywhere a distance from land, it always appeared to be very considerable, and have observed the Indians fishing in upwards of a hundred feet of wat within a stone's throw of the shore.

The following are the names, in order of apparent size, of the sixte largest streams flowing into the lake, and their positions are shown on t accompanying map: Kay-oshk or Gull River, Na-me-wa-min-i-kan or Sturgeon River, sometimes also called the Poplar Lodge River, fr the name of the Hudson Bay Company's post at its mouth, O-na-ma- sagi or Red Paint River, Pick-i-ti-gouch-ing or Muddy River, Ka-bi- ti-quia or the river which runs parallel to the shore, Om-ba-bi-ka or Risi Rocks River, Wa-ba-nosh or Dawning Day River, Ka-ma-ka-te-wa-ga-n or Black Water River, Posh-ko-ka-gan River, Ka-wa-ba-ton-gwa or Wh Sand River, Ka-ba-sash-kan-da-gi-sino River, Pa-jit-chig-a-mo or Look-o River, Sandy River, Katch-an-ga-ti-na-wi or High Hill River, Ka-nee-sh and Ka-nee-sha-sing River.

The aspect of the country immediately around Lake Nipigon, and the islands within it, is undulating and sometimes hilly, although le tracts of considerable extent occur in some places, and will be ag referred to in describing the soil. The most prominent or noted ele tions near the lake, are those of Three Mountain Point near Flat Ro

?ortage, Grand Cape, the hills on the south-east end of Grand Island, 'chiatang's Bluff on the east side of Black Sturgeon Bay, a low range erminating in Echo Rock near Nipigon House, Mount Royal on Jackfish sland (so called from its resemblance to Montreal Mountain), the Inner nd the Outer Barn, Mount St. John, and the Sugar Loaf. The height f Echo Rock we found to be 241 feet above the lake, of the Inner Barn 22, and of the Outer Barn 574 feet above the same level. Lake Nipigon.

In regard to geographical names, we endeavored to ascertain all those ised by the Indians, both in reference to places on Lake Nipigon itself nd in the surrounding country. These we always adopted in preference) any others. For the correct meaning and mode of spelling the Indian ames, I am indebted principally to Mr. Henry De La Ronde, of Poplar odge. There are, however, many geographical features for which the ndians appear to have no distinctive names. When names of any other rigin existed for these, we always adopted them. There still remained any localities for which we could hear of no designation whatever, and then became necessary, for the convenience of description, to give names) them.

Geological description.

East Side.—The following geological description of the eastern side of ake Nipigon from Flat Rock Portage, on the south side, to Meeting Point, : the northern extremity, is taken from Mr. McKellar's plans and notes.

Following the shore eastward from the portage, the only rock to be und, with the exception of an exposure of limestone, about to be noticed, the black or dark gray columnar trap, supposed to belong to the crown- ig overflow (12); until reaching a cove one mile north of Black Water iver, where Huronian rocks begin. On Columbus Point and Prince lfred's Island, which lies close to it, the trap is coarsely crystalline and ontains much magnetic iron. It is cut by numerous ill-defined veins of right red orthoclase feldspar, holding grains of semi-translucent quartz. n the vicinity of the outlet of the Nipigon River the shores are bold, ising from 50 to 200 feet above the lake, with but little soil. Both fine nd coarse grained varieties of the trap occur here; the weathered urface of the latter often shewing large crystals of black pyroxene. ast of the outlet a deep narrow bay, forming the south-eastern extremity f the lake, and called by the Indians Pi-jit-a-wa-bi-kong, runs southward arallel with the river. The ground is bold and rocky on each side of is bay, and rises to heights varying from 100 to 300 feet above the lake; hile a prominent point on the east side, called Green Mountain, rises to height of upwards of 400 feet. Trap rocks.

Limestone.

The limestone which has just been referred to, is met with on the e
side of Cook's Point, two miles west of the outlet, where it extends fo
mile along the shore, and in some places rises from fifteen to twenty f
above the water. It is thinly bedded, and consists of alternating whit
and olive-green layers. The rock, which has a fine homogeneous text
and conchoidal fracture, is magnesian and argillaceous, and when bu
would probably form a good cement. Some indistinct forms, resembl
fossils, occur in it, but nothing definitely organic was observed. The li
stone band is generally horizontal, but in some places it is thrown int
series of small anticlinals, having their axes north and south. It is overl
by the trap, which rises to a height of about 100 feet immediately ab
it. Near the contact of the two rocks the limestone is somewhat alter
being white and crumbling, as if calcined, while the trap holds redd
greenish and dark brown nodules and veins, together with small veins
white calc-spar and quartz. For a space of ten or twenty feet above
limestone, the trap is filled with red specks of oxide of iron, proba
resulting from the pyrites which commonly prevails in the rock.

Huronian rocks.

From the bottom of the cove at which the Huronian rocks begin
valley runs eastward from the lake, and is overlooked on the south side
a trap bluff, nearly 300 feet high. The rocks occupying the lo
ground to the north, consist of dioritic slates, dipping generally N.
W. (mag.) $<83^\circ$. Some of the beds are made up of elongated mass
running with the stratification, and varying from a few inches up to one
two feet in their longer diameters. The inclosed masses are harder
more compact than the slaty matrix, but otherwise have much the sa
character and appearance. Quartz veins, running with the stratifi
tion, are very numerous. They are of a lenticular form, genera
diminishing rapidly in thickness each way. Where one vein ends anot
usually begins at a few feet on either side of it. The largest are four
five feet thick in the middle. The quartz has a barren appearance,
nothing of a metallic nature was observed in any of the veins. Many
the slate beds on each side of them are chloritic, and have smooth shini
surfaces. These Huronian rocks extend to the bight of the bay on
south side of Grant's Point, a distance of two miles and-half. Here
trap again makes its appearance, and occupies the shore to the south s
of Sandy River, but it does not appear to extend far inland.

From this river the dioritic slates continue for five miles, terminating
a cove, three miles in a straight line, north of Poplar Lodge, which is
the mouth of the Na-me-wa-min-i-kan River. On the north side of San
River, they appear to dip southward at an angle of 45°, and at Pop
Lodge, N. 55° W. $< 85^\circ$. In the vicinity of Poplar Lodge, besides t
ordinary diorites and dioritic slates, there are chloritic slates and diori

ate-conglomerates. The enclosed masses in the last mentioned rock are th rounded and angular, and vary in size from small pebbles to boulders fragments six inches in diameter. They are lighter in color than the atrix, and shew more distinctly on worn surfaces, especially when wet, an in fresh fractures.

From the above mentioned cove, three miles north of Poplar Lodge, e trap occupies the shore to a bay seven miles farther on. At the ttom of this bay a green slaty rock, supposed to be Huronian, makes it pearance, and is followed by quartzite, which may belong to the same ries. The quartzite is sometimes interstratified with irregular beds of eenish chloritic and dioritic slates, and broad bands of a red granitic rock. he strike in this neighbourhood varies from about east to south-east, and e dip is vertical. For two or three miles south of Livingstone's Point, e rocks are of a gray gneissoid character, and are often cut by granite ins, running in different directions. Livingstone's Point. which is five les long and from one to two miles wide, is composed of trap, rising to e height of 200 or 250 feet on the north side.

The rock, both of the islands and the main shore in the eastern part of umboldt's Bay is gneiss, mostly fine-grained and compact. On a small Gneiss. and two and a-half miles south-west of the mouth of the O-na-ma-ni-sagi ver, which enters the bottom of the bay, the gneiss dips northward at angle of about 80°, and is composed of whitish quartz and fedlspar, with ck mica so arranged as to give the rock a schistose appearance. It is by a great number of branching and reticulating veins, varying from lf-an-inch to one foot in thickness, and belonging to three distinct sets, Granite veins. e newer cutting those of older date. They are composed of red feldspar, ite quartz and black mica. The newest set is coarsely crystalline, and ntains but little mica; the oldest is the least crystalline, and contains ca in sufficient quantity to give it a dark color; while the second set is ermediate between them in both respects. On an island lying one mile st of the mouth of the O-na-ma-ni-sagi River, regularly stratified gneiss, which hard slaty micaceous beds predominate, dips N. 14° E. (mag.) 75°, and rests upon a massive granitic rock. Thin, somewhat granular artz layers or veins in the micaceous gneiss, on the west end of this and, carry copper pyrites. A few trap dykes cut the gneiss on some of e islands in the eastern part of this bay, their courses being between rth and north-west. The largest one observed is about fifty feet thick. ykes are rare on the shores of Lake Nipigon, only a few besides those in s locality having been observed. Along the north side of Humboldt's y the gneiss is overlaid by trap, which appears to occupy a considerable ea in this neighbourhood.

Both the southern and northern extremities of the South Peninsnla of

Ombabika.

Ombabika are composed of trap, the central portion being occupied reddish coarsely crystalline granite or granitoid gneiss, with trap on s of the points and islands on the west side. Sandstone of a light g color, rather fine-grained, hard and quartzose, occurs on the shore in th or four places between five and six miles south of the entrance to Om bika Bay. It flanks the granite, and strikes northward with the sh dipping eastward at an angle of 15° in one place, and at another westw nto the lake, at an angle of 80°. Trap, in the form either of beds great dykes, is associated with it.

Ombabika Bay is nearly twenty miles long in a north-westerly direct Viewed from the opposite shore, the country all along its north-eas side, appears level and covered with green wood. Gneiss occurs near mouth of the Ombabika River, and on a low islet about a mile north-w of it, and again on a point eight and a-half miles north-west of the ri In all of these localities it is intersected with small granitic veins, an the one last mentioned, shows on the surface very distinctly the outl of angular pieces of syenite imbedded in the mass.

Ombabika River.

In ascending the Ombabika River, Mr. McKellar made three porta around rapids or chutes of about ten, thirty and twenty-five feet fall, res tively ; the last being about two miles in a straight line from the la Above this, the Indians informed him that no more portages occur fo long distance, and that the river passes through a lake lying seven or ei miles from its mouth in an easterly direction. The Indians all agre describing the Ombabika River as flowing through a level country. I said to rise in a lake three miles long, from which a stream also flows the Albany River. From the mouth to the third fall the banks are f forty to eighty feet high, the lower portion being a calcareous blue c and the upper a mixture of sand and clay ; while above this fall the s face of the country appears to maintain the same general level as be it, the banks only rising from ten to twenty feet over the river. The is excellent, being a dark-colored crumbling loam, free from boulders, supporting a thick growth of tall, but not large spruce, balsam, tama poplar and white birch trees. The rocks at the third fall are gne with beds of a white granular quartz holding occasional scales of m and crystals of iron pyrites. The portage is 390 paces long, and appe to be much used by the Indians. At the lower end the gneiss dips 40° W. (mag.) < about 45°, and at the upper, where the bedding is v distinctly marked, S. 30° W. (mag.) < about 60°.

The north peninsula of Ombabika, about twelve miles long, appears be composed entirely of trap. Between this peninsula and Meeting Po the country north of the lake seems to be all trap, rising in hills, someti 300 or 400 feet high, while some points on the lake shore consist of gne

aving generally a north-western strike. At one place, a short distance ıst of Meeting Point, the rock consists of epidosite, beautifully banded ith shades of a darker and lighter green. In the same neighborhood a ne-grained variety of the trap is cut by small veins of thomsonite. Lake Nipigon.

West Side.—Starting again at Flat Rock Portage, the fixed rocks of ıe whole shore, and of the islands, as far as they came under our obserıtion, consist of the black or dark greenish-gray trap, with a few exceptons, which will presently be described. The trap is generally crystalline, ›arse-grained massive and columnar, and contains, in addition to the feldıathic and augitic minerals, magnetic iron and iron pyrites. Under the fluence of the weather, much of it becomes friable, and crumbles into ravel-like pieces, and eventually into soil. The process is no doubt aided y the decomposition of the pyrites, which is present, often in considerable ıantities. This circumstance, and the columnar character of the trap, ccount for the peculiar effects arising from its denudation, producing an regular and generally rocky coast-line, and many islands, with deep water ound them, combined with good soil on the land. The trap is so strongly agnetic as to render the compass generally unreliable, and often totally ıserviceable in its neighborhood. The coarse-grained varieties were obsered to be more strongly magnetic than those of a finer and more compact ıaracter. When not strongly affected by local attraction, the variation the magnetic needle ranged from 2° to 6° east of the true meridian. /here the bedding is distinct the surfaces often present reticulations esembling those formed in mud left by the drying-up of pools. These e marked, either by a difference in the color or in the character of ıe rock, causing them to weather out more rapidly than the rest of the ass. Distinctly marked stratification is, however, of exceptional occurence, so that we were unable to determine the general structure and rangement of the rocks throughout this great trap region. The first ace at which well-marked bedding was noticed occurs on the west side Long Point, where, at about three miles south of the extremity, the eds, which are from one to four feet thick, and exhibit the reticulating rack-marks, dip westward into the lake at an angle of about 70°. On a nall islet close to the shore at this locality, numerous small veins followg the joints in the trap, are filled with flesh-coloured thomsonite. Columnar trap.

On the east shore of Black Sturgeon Bay, from the commencement of ıe narrow arm leading to the portage, for a distance of about two miles, ıe trap is interstratified with beds of argillite, felsite and sandstone, all ı edge, and running in a northerly direction. These rocks appear along ıe margin of the lake, at the foot of Tchiatang's Bluff, 400 or 500 feet igh, which runs for four miles along the south-east side of this bay; but ıeir relation to the great mass of trap constituting this bluff was not

determined. Some of the felsite beds are soft greenish and eart others harder and schistose. The argillite is hard dark colored and c *Lake Nipigon.* pact, with a conchoidal fracture; while the sandstones are light-colo and soft. One bed of the latter, of a very light greenish-gray color composed of fine silicious and argillaceous particles, with scattered gr of translucent quartz. High bluffs of trap continue down the east sid the arm towards the north-west extremity of Black Sturgeon Lake. Un these cliffs, at a distance of half a mile from the open bay, there is a b of light-gray tender harsh-grained sandstones, about 100 feet thick, dipp S. 80° W. (mag.) < 50°, which appears to come between great mas of the coarse crystalline trap. Two miles further south, or abou quarter of a mile north of the extremity of Black Sturgeon Lake, beds a coarse light-gray sandstone, holding occasional pebbles, mostly of w quartz, are found lying against the side of a hill of gray splint schistose felsite. The sandstone dips south-westward at an angle of ab 40,° while the felsite dips in the opposite direction, with an inclinatio about 60°. At the point on the south-west side of the Narrows, at entrance to Chief's Bay, the trap is in beds from one to five feet thi dipping north-eastward into the lake at an angle of about 40°.

On the opposite side of the Narrows, which are half a mile wide, *Limestone.* trap is overlaid by compact argillaceous magnesian limestone, with a c choidal fracture, dipping S. 25° W. (mag.) < 5°. The beds are fr three inches to two feet and a-half in thickness, and present differ shades of a grayish and olive-green color. Although the section expos does not appear to exceed ten feet in thickness, so regular and sligh the dip that these rocks extend for a quarter of a mile along the sho and are seen along a brook to the north-westward, and in the bottom of lake in front. Small pear-shaped bodies, about the size of peas, weat out on the surfaces of some of the beds, but they show no organic str ture, either outwardly, or in sections examined under the microsco The same olive-green limestone occurs again on the north-east sho of Chief's Bay, about two miles from the Narrows. The beds from six inches to two feet thick, and dip S. 40° W. (mag.) < 8°. section of six or eight feet is exposed, and the strata are underlaid c formably by beds of fine-grained compact black trap, shewing crack-ma on the surface. Similar trap is met with, in thin beds, only from six inc to one foot in thickness, at the foot of the first rapid on the Poshkoka River, about three miles south of its mouth, which is at the south extremity of Chief's Bay. The dip is here N. 60° W. (mag.) < 5°. the west side of the river, at this rapid, a bank, composed of gravel, sa loam, clay and boulders, rises to the height of sixty or seventy feet. its side, and in the bed of the stream, are many angular fragments, so

them of large size, of gray, red, darker and lighter green and mottled ndstone and indurated marl, and others of a soft white marly limestone; ich, my Indian guide informed me, occurs *in situ* on this river at out thirteen miles, in a straight line, south of its mouth. The same n pointed out to me a spot on the west side of the Poshkokagan, about f a mile below the first rapid, at which a spring of brackish water issues m the mud, when the river is low.

A small island, only a few chains in length, lying at the bottom of and Bay, and about one mile north of Tchiatang's Bluff, is composed of rse light gray gneiss, consisting of quartz, feldspar, and a little mica, Gneiss. h a few thin interrupted bands of mica-schist. The stratification is tical, and runs about N. 85° W. (mag.) The trap nearest to this nd is very fine-grained, tough and compact. This was the only exposure gneiss observed around the whole of the southern and western shores the lake, as far as Wabinosh Point; unless, indeed, some patches of ite-weathering rock, which were observed behind the shore, near the th side of West Bay, should prove to be Laurentian. The gneiss gins on Wabinosh Point, at one mile north of the bay of the same ne, and continues in a low narrow strip along the shore, for a distance one mile and three-quarters, and is overlaid by the trap, which rises in fs 300 feet high, immediately above it. The rock is of a light gray or, and composed of white quartz, feldspar, and black mica, with strings epidote. Mica-schist and coarse red feldspar-rock are associated with n one place. The general dip is S. 15° E. (mag.) $< 65°$. Gneiss is in met with on several small low points and islands, for three miles ng the shore opposite Windigo's Islands, in the north-western part of lake. It is of the same character as the last, and like it, contains, asionally, patches of mica-schist and of coarse red crystalline feldspar. the distance mentioned, the bedding appears to have a synclinal form, ping north at an angle of 30° in the south part, and south at an angle 15° in the northern; being evenly stratified in both localities, but somet disturbed in the central part. The most northern of Windigo's nds is composed of gneiss, the others of trap. The north shore of ndigo's Bay is low, and the country behind, level, with three isolated ical hills rising from it, within sight of the lake. The most remarkable hese is the Sugar Loaf, about 300 feet high, and lying at a distance of miles and a-half northward from the mouth of the Pickitigouching er. This river was surveyed for a distance of four miles and a-half n the mouth. The only rock met with was a small hill of trap on the t side, at two miles from the lake. The high ground on Meeting Point, the east side of Windigo's Bay, consists of trap, which is mostly fineined near the shore, while the islands at its extremity, and some of the

small points to the north-eastward, are composed of gneiss. The l
Lake Nipigon. rock is mostly of a hard gray massive variety, made up of whitish q
and feldspar, with black mica. The last mentioned mineral is abun
in some places, and the whole rock occasionally passes into mica-sc
In the more quartzose portions, epidote occurs in strings and dissemin
particles. The dip is generally north-eastward. On the north poi
an island three quarters of a mile west of the extremity of Meeting P
there is an irregular vein of white quartz, a few inches wide, runnin
50° E., and carrying specular iron and crystals of green epidote.

The lake shore, and the islands from the Hudson Bay Company's
at Nipigon House, to English Bay, a distance of three miles, are occu
Feldspar-porphyry. by a brick-red porphyry, composed of crystalline red orthoclase feld
with grains of translucent quartz, enclosing finer stratified patch
the same color, and others of white quartz. It also holds spot
a soft green earthy mineral, and small cavities lined with crysta
feldspar. A point on the west side of Jackfish Island is also compos
this red rock. In some places it is broken into regularly shaped b
of a convenient size for building.

The shore, just below Nipigon House, is covered with an
Sandstone. blocks and slabs of very evenly bedded, rather fine, free-grained s
stone. In one of the fields, just south of the house, a conside
number of large angular masses of the same rock occurs. It is most
a rich, dark reddish-brown color, and being easily worked, would ma
fine building stone. Some of it splits beautifully into very even
parallel-surfaced slabs, which would form excellent flagstones. T
thinly bedded portions consist of alternating reddish and grayish la
each only a few inches thick. We were informed that an excava
which had once been made near the shore at this place, shewed some
of the sandstone lying horizontally, *in situ.* Angular fragments of c
gray sandstone with ripple-marked surfaces, and of a soft friable
gray argillaceous rock are numerous at Nipigon House.

Dog Island, lying in front of Nipigon House, and separated from
mainland by a channel a quarter of a mile wide, is composed of
grained black trap, apparently lying almost horizontally. On the
land opposite the south end of Dog Island, fine-grained black trap
occurs, and dips S. 20° E. (mag.) 5°. Mount Royal, on Jackfish Is
is about 400 feet high, and consists of trap, which is fine-grained nea
junction of the red porphyry, on the west side of the island. The st
fication appears to be nearly horizontal, and the worn surfaces of some
on the shore exhibit closely reticulating crack-marks, very conspicuo
The most northern island in English Bay, and the point between this
and Wabinosh Bay, consist of the black trap. The red porphyry, and

sandstone of this locality, would therefore appear to be overlaid to the th, east and north by this rock.

Wabinosh Lake.

A survey was made of the lower Wabinosh Lake, and of the river con- ting it with the head of the bay of the same name. The trap hills und Wabinosh Bay, and the lake just mentioned, are from 400 to 500 high; while the Inner Barn, with its sides of columnar trap, rises like reat castle, in the middle of the bay, to a height of upwards of 600 , and appears to be the highest point around Lake Nipigon. The er Barn, four miles east of the others, and having much the same earance, we found, by means of the aneroid barometer, to be 574 feet eight.

Geological notes.

udging from the descriptions and sketch-plans obtained from the ians, the country drained by the streams from the south-westward, ing into Lake Nipigon, and the region for a considerable distance west he Black Sturgeon River, is occupied principally by the black trap and marls or sandstones of the Upper Copper-bearing series. According he same sources of information, the black trap, interrupted by occa- al areas of Laurentian rock, extends to a still greater distance west- d from Lake Nipigon, and is followed by flat-lying limestones. From description by Dr. Bigsby (*Jour. Geol. Soc. Lon.*), I should judge the high islands which he observed in Whitefish Lake, between Lonely e and the Lake of the Woods, consist of columnar trap, like that of igon. I understand that Mr. McTavish, of the Hudson Bay Company, observed limestone with abundance of fossils around Lonely Lake, on English River; and my Indian guide assured me that he had seen a rock, ch, from his description, I judged to be of the same character, opposite a lson Bay Company's post on the Kon-a-don-wen-gwak, or Sand Lake, on Albany River; apparently in a position corresponding with the north- ern extremity of the so-called "Lake St. Joseph," of some maps. He also rmed me that he had seen black trap, similar to that of Lake Nipigon, the Albany River, both above and below the place at which the lime- e occurs; and limestone again below the lower locality of the trap, or veen it and Martin's Falls. I learn from Mr. Geo. Barnston, formerly he Hudson Bay Company, that gneiss crosses this river at Martin's s, below which the unaltered strata, referred to by Sir John Richard- continue to the sea. From the descriptions of the Indians, it would ear that a gray limestone occurs along the upper part of the Ombabika er, which, as already stated, they describe as flowing through a level ntry.

t would therefore seem that between Lake Superior and the palæozoic on around James's Bay, there is a complete break in the continuity of Laurentian and Huronian range. A part of this interval is occupied

by Lake Nipigon and the surrounding country. The true age of the U
Copper-bearing rocks of this region may perhaps be most easily detern
by tracing them to their contact with the fossiliferous palæozoic strata t
north or north-west of Lake Nipigon.

Overlying trap.

The trap rocks of Lake Nipigon, and the country between it and
Superior, probably belong, partly to the eleventh division of the list v
I have given, on page 318, and partly to the crowning overflow. This
be regarded as the newest rock of the whole region, since no strata
yet been found lying upon it, either in the Nipigon district, or ar
Lake Superior; while, on the other hand, it is found resting in diff
places, upon almost all the other rocks of the country. The followin
of those rocks with which the trap overflow has been seen in contact,
pitulates briefly a number of examples already mentioned:

Contacts.

1. Laurentian gneiss, at the Long and the One-mile Portage o
Nipigon River; on the north-east side of Black Sturgeon Lake; and a
numerous localities which have been mentioned in the northern pa
Lake Nipigon, from Wabinosh Bay to Livingstone's Point.

2. Huronian slates in various places on the east side of Lake Nip
from Black Water River to Livingstone's Point; and also on what a
to be Huronian quartzites at the north-east side of Lake Maria.

3. Cherts, shales, etc., (2 and 3) of the lower portion of the U
Copper-bearing rocks, south of the Kaminitiquia River, and alon
coast of Lake Superior from this river to the boundary line.

4. Argillaceous sandstones (4) of the same group on Thunder Ca

5. Dolomitic sandstones and conglomerates (5) of the same gro
Wood's location.

6. Red argillaceous limestones on the east side of Nipigon Harbor
Red Rock.

7. Red marls on the west side of Nipigon Harbor, and in the is
hill which has been mentioned as occurring near Black Sturgeon Riv
the portage from Nipigon Bay.

8. Red marls, shales and sandstones along the lower section c
Black Sturgeon River.

9. Flaggy arenaceous and silicious gray shales, a short distance w
Red Rock.

10. Brick-red quartziferous porphyry, and probably red and gray
stone, at Nipigon House.

11. It is also found, apparently in contact, with the trap, sands
argillites, soft greenish and gray splintery shaly felsites, occurring
the east side of Black Sturgeon Bay, on Lake Nipigon, to the no
extremity of Black Sturgeon Lake.

12. Also, apparently, with the rocks of the eleventh division,

ninsula between Black Bay and the main body of Lake Superior, rming some of the higher points, such as The Paps.

SURFACE GEOLOGY.

Except in the Laurentian region around Dog Lake, the surface of the untry examined does not generally present a rounded or mammillated pearance. This is owing to the fact that the greater part of the area is cupied by the Upper Copper-bearing rocks, which, being of unequal hardss, and with a stratification approximately horizontal, give rise, by denution, to level tracts and vertical cliffs.

Glacial Striæ.—The glacial striæ belong to two sets, one running westrd and the other southward. Around Lake Nipigon, the two sets often Ice grooves. ersect each other, the one having a western course being the more ent. The following table gives a number of examples of the courses erved in different places, the directions being referred to the magnetic ridian. The variation averaged about 5° east of the true north.

	Older set.	Newer set.
Red River Road, 10½ miles from Thunder Bay	S. 25°E.	....
do do 13 do do do	S. 25°E.	....
do do 5 do do do		About W.
Mining-lot H, township of McIntyre		S. 75° W.
Kaminitiquia River at intersection of Red River Road		S. 75°W.
South side of Dog Lake		S. 70°W.
Near north end of Lake Maria on the Nipigon River	About S.	....
Lake Nipigon.		
North-west side of McIntyre's Bay, near portage		S. 65°W.
Extremity of Long Point on east side of Grand Bay		S. 70°W.
Small island at the bottom of Grand Bay		S. 70°W.
Isd. on W. side Grand Bay 4½ miles N. of Tchiatang's Point	S. 10°W.	S. 60°W.
Point do do 7 do do do		S. 75°W.
West side of entrance to Gull Bay		S. 80°W.
Rocking-stone Isd. between entrance to Gull Bay and West Bay		S. 80°W.
Small island in the same vicinity		S. 85°W.
Largest island in West Bay		S. 85°W.
North end of Dog Island, opposite Nipigon House		S. 80°W.
Point on west side of Jackfish Island		S. 80°W.
Shore opposite Windigo's Islands		S. 60°W.
W. side of Britannia Island, S. W. of Meeting Point	S. 30°W.	....
Extremity of Meeting Point		S. 75°W.
Island two miles W. of entrance to Ombabika Bay		S. 55°W.
Southern extremity of S. Peninsula of Ombabika	S. 13°E.	S. 65°W.
Point about two miles north of Poplar Lodge	S. 5°W.	S. 55°W.
Poplar Lodge Point	S. 10°W.	S. 60°W.
Point 3½ miles south of Poplar Lodge		S. 85°W.
Columbus Point		S. 45°W.

Ice grooves.

On the east side of the northern extremity of Lake Maria, the groo
is well seen in horizontal lines, up to a considerable height above the w
on the side of a perpendicular cliff facing west. Grooves were obse
slanting, first downward, then upward, forming a regular curve, on the
of a vertical wall of trap on the west side of Grand Bay, Lake Nipi
At one place in the same vicinity, where the grooves shoot up a very s
slope, rising out of the lake, they were observed to diverge in a fan
form, from a depression in the surface of a rock. Around the p
between English and Wabinosh Bays, where the shore is bold, and the w
deep, the striæ run westward, up very steep inclinations, in some p
approaching the perpendicular; in which cases the grooves are short
the rock has a battered appearance. Occasionally the steep grooved su
has a curved form like that of a plough-share. The westward course o
more recent set of grooves will account for the greater general dep
the western side of Lake Nipigon as compared with the eastern; whil
north and south bays of the southern side may have been eroded b
agencies which produced the southward set of grooves. The large a
at which the two sets of striæ often intersect each other, on even surf
is a fact worthy of note in regard to the question as to whether the gr
were produced by glaciers or icebergs.

Drift.

Drift.—Boulders and pebbles derived from the Upper Copper-be
rocks of the peninsula between Black and Thunder Bays, have
strewn over the surface of the older formations in the country immed
west of the latter bay; just as the *debris* of the Lower and Middle Si
rocks has been carried westward over the higher strata of the we
peninsula of Ontario. On the west side of the Kaminitiquia, at the int
tion of the Red River Road, boulders, with a small admixture of
material, are thrown up in conspicuous ridges and hillocks at the b
the hills, which rise to the height of about 400 feet immediately
them. These accumulations appear to have formed the terminal mo
of glaciers proceeding from the valley of Strawberry Brook, di
opposite.

Around Lake Nipigon the materials of the drift have also evi
travelled westward. On the north side of Wabinosh Bay, great bo
from the low gneissic area already described, have been carried
direction, and scattered upon the overlying trap. One of these,
upon a hill-side on Wabinosh Point, a quarter of a mile back from the
measures twenty feet in diameter, and is distinctly seen as a whit
from the level of the lake, at a distance of seven miles. All alo
north-west shore of the lake, from Wabinosh to Windigo's Bay, the
numerous boulders of fine-grained hard light-gray quartzose sand
broadly ribboned with lighter and darker shades of pink. Some o

e rather coarser-grained than the average, and contain pebbles of white artz, and more rarely of red jasper. These sandstone boulders have obably been brought up from the bed of the lake, between this part of e shore and the islands to the eastward. Laurentian boulders were dom seen around Lake Nipigon, except in the vicinity of the same rock *situ*. Small rounded fragments of light cream-gray limestone, con- ning a species of *Pentamerus*, were occasionally found on the east side the lake; and a somewhat angular mass of the same rock, measuring arly three feet in diameter by a foot and a-half in thickness, was met h on Gneiss Island, at the bottom of Grand Bay. The limestone of s block was very pure, soft, and somewhat porous, and full of rather perfect fossils, the commonest being a *Pentamerus*, which, Mr. lings says, is very like some of the forms of *P. galeatus*, but probably ew species. Mr. Billings also recognises amongst these fossils a species *Favosites*, with small tubes about half a line in diameter, a *Rhynchonella*, l a species of *Zaphrentis*, about one inch in length. He says: "These sils are not sufficient to determine the age of the deposit from which y were derived, except in a general way. It is not Lower Silurian, l is not so recent as the Middle Devonian. I think it about the age of Niagara formation." I may here mention that, in 1846, Sir William gan collected, on the shore of Lake Superior, east of Pic Island, a nber of fossils in loose pieces of light yellowish-brown limestone, and ne in gray and yellow chert. These fossils have recently been examined Mr. Billings, who says that they "belong to the genera *Favosites*, *phrentis*, *Streptorhynchus*, *Atrypa*, *Orthis*, *Pterinea*, *Dalmanites* and *perditia*. They are Devonian. The only determinable species is *Orthis vensis* (Hall), a species characteristic of the Hamilton group in Iowa. It urs also, far north, on Laird River, and on Snake Island in Lake Winnipe- is, in the same kind of rock,"—a light yellowish-brown limestone. Mr. omas Herrick, P.L.S., informed me that he crossed a patch of flat-lying siliferous limestone, some two or three miles in breadth, on the Pic River, ere his line intersects it, at about thirty-two miles, in a straight line, thward from its mouth. Fragments of olive-green limestone, similar hat described as occurring in place on Cook's Point and the north-east e of Chief's Bay, on Lake Nipigon, were found on Champlain Point l Britannia Island, in the same lake, and on the shore of Lake Superior, r Sucker Brook. Erratic blocks.

Ridges and Terraces.—On the south side of Dog Lake, terraces of sand l gravel, from fifteen to twenty feet high, are seen in some places close the present beach. The high ridge crossed by the portage from Little Great Dog Lake is covered with fine sand. On the north side of the minitiquia, beginning opposite the mouth of the Whitefish River, a

regular terrace, apparently of gravel and sand, burnt bare of vegetat and about forty feet high, runs eastward, close to the river, for a dista of about two miles. A ridge of boulder-drift about forty feet high, cr ing the Nipigon at the foot of Lake Helen, near Red Rock, and anot sixty or seventy feet high, at the first rapid on the Poshkokagan Ri have been already mentioned. A ridge of sand, with boulders and sto rising to a height of thirty or forty feet out of a level sandy plain, running in a westerly direction, crosses the Kabitotiquia River about miles, in a straight line, south of its mouth. It occasions a small ra seventy paces long, over trap boulders, with a fall of four and one- feet. This is the only rapid from the mouth of the river to a long dista above this point. At Champlain Point, the bank of the lake is al twenty feet high, and composed of loam and gravel, with boulders in lower part. Some of the latter are Laurentian, which are rarely see this part of the lake. A terrace of gravel and sand, rising to the hei of 150 or 200 feet above the level of Lake Nipigon, runs for a dista of about two miles along the shore between Echo Rock and West I Having been denuded of timber by some recent fire, these terraces a very conspicuous appearance as viewed from the lake. A ter about sixty feet high, composed of very fine white sand, runs for two r along the shore, northward from the mouth of the Kawabatongwa, and given rise to the Indian name, which means White Sand River.

Ice movements. *Effects of Recent Ice.*—The effects of the spring shoves of lake are observable in many places around Lake Nipigon, as well as I Superior, in the form of rows of boulders and shingle piled upon the be or just between it and the vegetation behind. Where the beach is s is often found that each boulder has ploughed a furrow from the marg the water to its resting place. The rows of shoved boulders were no particularly along the west side of Grand Bay, and between West Bay the entrance to Gull Bay. Very large boulders of trap have been p apparently by recent ice, upon the small islands in the latter bay.

None of the abrading effects produced by river-ice during the sp floods, on the banks, trees and bushes, such as are seen along many o rivers of Gaspé and the maritime provinces, were observed on any o tributaries of Lake Nipigon, or upon the Nipigon or Black Stur Rivers.

Sand and Clay Deposits; *Soil.*—In the hilly country around Thu Bay and Dog Lake, where any soil exists, it is usually a yellowish-b gravelly loam, with boulders. The sandy tract, underlaid by lamin buff, drab and bluish clay, along the lower reach of the Kaminitiquia R has been already described, and the existence of nodules in this cl referred to in the *Geology of Canada*, page 905. Along the greater

f this stretch, the banks, on alternate sides, are from forty to fifty feet igh, the upper half being yellowish sand, and the lower clay. The land low about the mouth of the river, and gradually dips under the lake. The urface is here sandy, but the clay is said to be found at the depth of a w feet, in digging wells, and a similar condition, no doubt, extends below e lake.

In the valley of the upper reach of the Kaminitiquia, a stiff red clay begins t four miles below the head of Little Dog Lake, and extends southward to e junction of the Mattawa. From this point it is found along the Red River oad, to a distance of about five miles eastward from the Kaminitiquia, radually rising to an elevation of 400 or 500 feet above its level. On e west side of the river, it is also found on the flanks of the hills above e boulder deposits already described, to the height of about 200 feet bove the river, and it is said to extend westward some distance up the alley of the Mattawa.

There is much good land along the north-west side of Black Bay. The untry is level and sandy from the head of this bay to Nipigon Bay, and sandy soil extends up the valley of the Black Sturgeon River. The sand, hich is very fine, appears to be underlaid everywhere in these parts by ay.

In the Nipigon country the largest tract of good land appears to lie on e south-western side of the lake. From the Nonwatan River, northward the Pajitchigamo, a distance of fifty miles, the country is comparatively vel, and the soil generally fertile; but we could not ascertain, from our n explorations, how far westward this tract extends. The Indians and hers, however, represent it as continuing nearly to the Winnipeg River, d becoming more generally level in receding from Lake Nipigon. Some the peninsulas in Lake Nipigon, within the above distance, are hilly, t the soil is generally good, even on these, consisting of a brownish am, sufficiently tenacious, when moist, to retain its form after having een pressed in the hand. The rivers entering this part of Lake Nipigon, far as examined, were found to flow, with tortuous courses, between uddy banks of clay, overspread with fine sand. The clay, as seen in the anks, generally appears sandy, from having become mixed with the verlying deposit, but when clean sections are obtained, it is usually und to be stiff, tenacious and free from grit. On the higher levels the nd is often coarser and interstratified with layers of gravel.

There is a considerable area of good land around the bottom of South d McIntyre's Bays, and on the peninsulas east of the latter bay and ull Bay. From the mouth to the first rapid on the Poshkokagan, the amy banks of the river are from twenty to thirty feet high. The Kabitiquia River is so crooked that by following its windings from the mouth

Sand and clay.

to the portage leading to Chief's Bay, the distance was estimated fully thirty miles, although it is only nine miles in a straight course. water is deep, and the current slack throughout, except at the slight previously mentioned. In ascending the river the banks rise graduall height, increasing from a few inches above the level of the water, a mouth, to five and ten feet, in the above distance. For the first five there is a wide open margin on each side of the river, covered with g On both sides, the country is level and the soil sandy, supporting a gr of grass and bushes, the timber having been all burnt off by repeated within the last few years. The land is free from stones, and very labor would be necessary to make it ready for the plough.

From the Kawabatongwa River to the Pickitigouching, the count low, near the lake, and a level tract extends northward to an unkn distance from Windigo's Bay. It is believed that in this direction a l area is overspread with light-colored clay. During the spring fres the waters of the Pickitigouching are said to be quite milky from clay which they hold in suspension, and hence the Indian name of stream, which signifies the Muddy River.

It has been already mentioned that the country is level, and the good, all along the north-east side of Ombabika Bay, and at leas far back from it, in a north-easterly direction, as the eye can re Below the first rapid on the Ombabika River, from twenty to thirty of the underlying clay are seen above the water; the upper part of banks, which are from forty to eighty feet high, being composed of s sometimes interstratified with clay. The clay, which is in horizontal b is free from pebbles or grit, light blue in color, calcareous, sticky plastic. Above the third portage the river does not cut so deeply these deposits, the banks being only from ten to twenty feet high. soil in this region is a dark-colored crumbling loam.

On the south side of the Sturgeon, or Poplar Lodge River, as far was examined, the banks, consisting of fine white sand, rise to the he of thirty or forty feet. An undulating sandy country extends for a or two to the southward of the river.

The beach sand around Lake Nipigon and Black Sturgeon Lake is o mixed with particles of magnetic iron, probably derived from the of the vicinity, but it did not appear to occur in any place in suffic quantity to be of economic value. Particles of garnet were abundan the sand in some places in the northern part of the lake.

Climate and Timber.—The climate of the Nipigon country appear be as well suited for agriculture as that of the greater part of the vince of Quebec. Farming has been successfully carried on, for a l time, by the Hudson Bay Company at Nipigon House. The timber aro

ake Nipigon is principally white spruce, white birch, aspen and poplar, alsam-fir, tamarac and white cedar, with occasional trees of black ash, rey elm, red and white pine. In the month of February last, I had the onor of giving full details on these subjects, in evidence before the ommittee of the House of Commons on Immigration and Agriculture, and understand that they will be published with the report of the Minister f Agriculture. Forest trees.

ECONOMIC MINERALS.

The Upper Copper-bearing rocks, all the way from the boundary line to Nipigon Bay, are cut by numerous metaliferous veins. These are so well escribed in the *Geology of Canada*, pages 74, 75 and 76, that in the resent state of our knowledge, little of a general nature can be added. s there stated, the veinstones consist of quartz, which is usually either methystine, or else white and granular, calc-spar, barytes, and variously olored fluor-spar; and where they cut the higher members of the series, eolites and other minerals are also frequently present; while their metallic ontents embrace "copper, lead, zinc and silver, with more rarely nickel, obalt, arsenic, uranium and molybdenum." Sir William Logan says, p. 74) "the indications which they present are such as to render it ertain that many parts of the country characterised by them will, sooner r later, rise into importance as a mining region." It is stated on pages 6 and 745, that a little gold had been met with in a vein on Prince's cation. Since the *Geology of Canada* was written, Professor Chapman, April, 1868, found the same metal in larger quantity in the ore of the ead Hills location near Black Blay. With regard to this ore, he says: Carefully conducted assays shew amounts of gold varying, per ton, from out 14 to 19 dwts., the mean of those already made giving 17 dwts. 12 rs., with 2 oz. 2 dwts. of silver." Mineral veins. Gold.

In reference to the course of the veins, Sir William Logan says (page 74): As in the case of the dykes, the mineral veins belong to two systems,—ne coincident with the range of the rock masses, and the other transverse it. They are therefore parallel to the dykes,"—the one system being bout N. and S., and the other varying from N.E. and S.W., to E. and W.; r, on an average, E.N.E. and W.S.W. It will be observed that these irections also correspond with those of the two sets of ice-grooves.

The additional information in regard to economical minerals obtained uring our explorations will now be given under their respective heads.

Iron.—Reference has been made to the occurrence of a mixture of agnetic iron ore with insoluble matter, chiefly silicious, in the form of thin-bedded deposit, apparently of considerable extent, and containing,

Iron ores.

in the specimen examined, 37·73 per cent of metallic iron. Dr. Hunt
this ore "might be smelted, but would require a large amount of l
stone as flux." Mr. H. P. Savigny, P.L.S., of Toronto, has shown
specimens of pure massive magnetic iron ore, which, he says, occurs in l
quantities a short distance from the shore of Thunder Bay, near Amet
Harbor. A specimen of pure botryoidal red hematite was given
which was said to have been found at Arrow Lake. Chief Manitous
of Lake Nipigon, showed me some earthy red hematite, used by
Indians as paint, which he says is found in abundance in a hill on the
side of Lake Nonwatanose. I have seen specimens of hard fine gra
red hematite, said to have come from the Red Paint River, and piec
the same mineral from thin veins, which are reported to exist just be
Nipigon House. Small quantities of specular iron were found in the
gneiss on the brow of the west-facing hills overlooking the Black Stur
River, due west from Red Rock, and the same mineral has been refe
to as occurring in a quartz vein on an island off Meeting Point. It
likewise observed by Mr. McKellar in small veins, in several places on
lake shore between Poplar Lodge and Sandy River. It has been alre
stated that the magnetic iron in the beach-sands around Lake Nipigon
Black Sturgeon Lake was in no place found in sufficient quantity to b
economic value. The Indians sometimes mistake the blacker and hea
varieties of the trap for iron ore, and might thus mislead explorers.

Lead ore.

Lead.—A lead-bearing vein was said to have been found last sumn
on Stewart's location on the north bank of Pigeon River, about two n
from its mouth; and veins were reported to have been discovered on I
Kee-zee-zee-kitchi-wag-a-mog and Whitefish Lake. On the north ban
the Kaminitiquia, a vein three or four feet thick, running north-e
ward, occurs on the 4th or 5th lot in the township of Paipoönge.
contains barytes, quartz, calc-spar and fluor-spar, with a little co
pyrites, iron pyrites, and galena. In the township of McIntyre, near
north-east corner of Neebing, pieces of similar veinstone, with crys
of galena, were found scattered upon the surface, indicating the n
proximity of the vein from which they have been derived. A large
containing all the above minerals, and also zinc blende, crosses the Paress
Rapids on the Kaminitiquia, at the intersection of the side-line betw
lots 20 and 21 of Paipoonge. Mr. Herrick, who surveyed this town
in 1859, reports that he observed the same vein some miles to the sout
the Kaminitiquia, and traced it, on the opposite side of the river, thro
the whole breadth of the township. He gives its width as varying f
ten to twenty five-feet. It is supposed by explorers to be identical
the lead-bearing quartz vein of the Algoma mine, which has been alre
mentioned as occurring on the north-west corner lot of Neebing.

'allbridge mine is on the west half of this lot, and here, a shaft, **Mineral veins.** ıid to be fifty feet deep, has been sunk on the same vein. Mineral eins of a similar character, and, for the most part, running in a direction pproaching E.N.E., have been discovered in a considerable number of calities among the Upper Copper-bearing rocks in the township of Mcıtyre, and along the north shore of Thunder Bay, and thence to Black ay. They are too numerous for separate description within the limits of this eport, but their positions are shewn upon the accompanying map. The rgest vein examined, occurring upon mining-lot M, has been already ıentioned. It is composed of quartz, with a very little calc-spar, and is of a oarsely brecciated character, much of it consisting of a net-work of small eins; its total breadth is forty feet. Openings which have been made pon it where it is crossed by McIntyre's River, on this lot, do not appear have brought to light any kind of ore. Its course is here N. 50° E. mag.) with an underlie to the S.E. of about 10° from the perpendicular. eing harder than the sandstones and shales of the country, it forms a nall ridge, which is rendered conspicuous by its white color. Mr. Macırlane describes a vein having the same character, width and course on hangoniah Island, in front of Wood's location, (*Can. Nat.*, Dec. 1869, . 461.) A vein of about the same breadth, consisting of calc-spar and arytes, with some specks of galena, occurrs on one of the small islands ing to the south-east of Pie Island, and was examined by two of our arty. I was unable to visit the Lead Hills location, which is situated in ie township of McTavish, at the distance of three or four miles west of **Lead mine.** ie shore of Black Bay, and where a rich vein of lead ore occurs in a pale ed indurated marl. In a report on this location, Professor Chapman says: The vein consists of a gangue of quartz, with enclosed portions of wallock, and some heavy spar, etc., carrying a very strong lode of intermixed opper-pyrites and galena. The vein itself appears to average about ten et in width; but, at present, it is to a great extent uncovered. The opper-pyrites and galena, although scattered more or less throughout the ein, run principally in a solid lode, of at least four feet in width. he course of the vein is about N. 65° E.; and so far as this can be etermined in the present undeveloped state of the vein, the dip, or undere, is toward the southwest, at an angle of about 80°." In one sample he ound 8.10, and in another 11.62 per cent. of copper. One of these samles also yielded 47·56 per cent. of lead. Professor Chapman's discovery f gold and silver in this ore has been already referred to. During our tay at Fort William, a number of blocks of solid ore were brought from he location, some of which would weigh several hundred pounds. A samle broken off one of them yielded, by Mr. Broome's analysis, 38.35 per ent. of lead, and this, by cupellation, gave nearly one ounce of silver and

half an ounce of gold to the ton of lead. Several other lead-bearing v
are reported as occurring in this neighborhood. A quartz vein, about
foot wide, and carrying a considerable quantity of galena, has been not
in the *Geology of Canada*, page 690, as cutting the granitic gneis
Granite Island in Black Bay.

On the east side of Lake Nipigon, Mr. De La Ronde reports a v
from which he has taken good specimens of galena on the Poplar Lo
River, at a few miles from its mouth. On the west side of the lake
Indian shewed me a specimen of drusy white quartz, holding galena, w
he said he had broken from a vein about four inches wide, running n
and south, on the Gull River, below Cedar Lake; three and a half
journey, by canoe, from Nipigon House. He also said that an
which I judged from his description to be copper-pyrites, was foun
the same place. Small specks of galena were met with in a loose f
ment of greenish marly limestone at the first rapid on the Poshkoka
River.

Copper ores.

Copper.—The deposits of native copper occurring among some of
higher members of the Upper Copper-bearing series, so far as they
known, are fully described in the *Geology of Canada*, pages 71 and
Many of the veins which are found cutting this series in the Thunder
region, and which have been noticed in the preceding paragraph, also
tain copper-pyrites, but none of them require further description. A
occurring just behind Red Rock, but which I was unable to examin
said to hold vitreous copper ore.

On the east side of Lake Nipigon, Mr. McKellar reports that the dior
and dioritic slates on the lake shore, on each side of Poplar Lodge,
traversed by a great number of quartz veins, carrying copper-pyri
with smaller proportions of purple ore and copper-glance; and he thi
that rich copper lodes may be discovered in this vicinity. Small qua
veins, or beds, carrying copper-pyrites, have been already mentioned
existing upon a small island in Humboldt's Bay. The Indians report
veins, one of a white, and the other of a reddish color, as traversing a h
island in Ombabika Bay, but none of those of our party who visited
island, observed them.

Copper was said to have been discovered near the Hudson Bay Com
ny's establishment at the mouth of the Wabinosh River, but we did
succeed in finding it. A vein containing amethyst is reported to oc
on the south branch of the Wabinosh River, at a point lying one and a
day's journey, by canoe, from Nipigon House.

Silver.—This metal has now been discovered in the native state o
the form of silver-glance, in at least seven different localities in the Th
der Bay region, the veins in most cases belonging to the north and so

…et. The silver-bearing vein of Prince's location is described at page 76 …f the *Geology of Canada*. Silver ore.

Last summer Mr. Macfarlane, agent of the Montreal Mining Company, …btained a quantity of silver ore from a vein on the Jarvis location. The …me gentleman has fully described the silver-bearing vein of Wood's lo- …ation in the *Canadian Naturalist*, 1868-70. The portion of the vein at …resent worked is upon Silver Islet, about one mile from the main shore …f Thunder Cape. " It has a width of about twenty feet on the north side …f the island, and to the southward divides into two branches, each seven … eight feet wide. The course of the vein is N. 32° to 35° W., and it …ps to the eastward at an angle of about 8°." The ore is a mixture of …ative silver and silver-glance in a gangue consisting mainly of calc-spar …d quartz, but holding also small quantities of galena, blende, iron and …pper pyrites, graphite, cobalt-bloom, nickel-green, and a mineral con- …ining arsenic, nickel and silver, which Mr. Macfarlane thinks may be … new species. The thickness of the rich part of the vein varies from a …w inches to two feet, and it keeps to the east or hanging side of the …ein." Up to the month of April of the present year, the value of the sil- …er taken from the crop of the lode on the islet, or rather in the shallow …ater beside it, since its discovery in the summer of 1868, is supposed to …nount to about $25,000. Wood's location.

The lode at the Thunder Bay silver-mine, which has been referred to … page 326, consists of a network of small quartz veins, occupying a …eadth of six or seven feet, and runs N. 34° E., with a slight underlie to …e north-westward. Two shafts have been sunk upon it, each to the depth … about seventy feet. Between them, part of the lode consists of a vein …ne of white granular quartz, about one foot thick, and in this most of the …ver has hitherto been found. It occurs principally in the form of irregu- …r branching filaments of the native metal, disseminated in the quartz in …olated bunches, in which the silver often forms more than ten per cent … the mass. One of these bunches, which was removed during our visit … the mine, weighed upwards of one hundred pounds. Silver-glance is …so present in small quantities ; the largest piece of this mineral which … saw would weigh about two ounces. The silver appeared to be most …undant in the upper fifteen feet, where the wall-rock, as mentioned on …ge 326, differs from that farther down. In the lower part of the mine …lver-glance only has been found. Thunder Bay Mine.

The workings at the Shuniah mine, two miles west of the last, being full … water, could not be examined ; but from the description of Professor …hapman, it appears that the conditions here are similar to those at the …hunder Bay mine, except that the vein runs nearly east and west.

At the Silver Lake location, about four miles north of the head of

Thunder Bay, the silver occurs as small grains, in the native state, dark colored blende, in a vein of quartz. Another locality of silver i McKellar's Island, one of the small rocky group south-east of Pie Isl Here the metal occurs with blende, as in the last locality, but the veins is mostly coarse calc-spar.

Gold.

Gold.—The existence of gold, in a vein on Prince's location, is tioned in the *Geology of Canada*, pages 76, 517 and 745, and some in regard to its occurrence in a vein on the Lead Hill's location are g on page 357, of the present report.

Manganese.—Many of the boulders and pebbles uncovered, in mal the Red River Road, about half way from Thunder Bay to the Kami quia, are coated with black oxide of manganese.

Salt springs.

Salt.—The brine-spring at the head of the first rapid on the n branch of the upper section of the Black Sturgeon, is described on page and another has been mentioned as occurring half a mile below the rapid on the Poshkokagan. My Indian guide informed me that a t was to be found near a small clear-water brook on the west side of Bay, about a mile north of the mouth of the Kobitotiquia River. A h ful of salt was obtained by boiling down about two quarts of the wate the first mentioned spring, but having afterwards become accidentally the greater part of it was dissolved away, so that any analysis of remained would be of no value.

Limestone.

Limestone.—Rock fit for burning into lime can probably be obtai among the beds of division 8, page 319, near the eastern line of Wo location, as well as from the calcareous strata on the east side of Nipi Harbor; and perhaps also among the dolomite bands of the lower gr which have been described as occurring at the head of Thunder Bay, the Thunder Bay silver-mines, and in the southern part of the townshi McIntyre. The calcareous spar of some of the larger veins on the c and islands between Pigeon River and Fort William may also prove able for the same purpose.

The specimens of the limestone from the north-east shore of the Ch Bay, Lake Nipigon, which have been analysed by Mr. Broome, con 38.5 per cent of insoluble silicious clay, which is probably in so larg proportion as to prevent the rock, when calcined, from forming, by it a good cement. The soluble part is a magnesian carbonate of lime, of w one quarter is carbonate of magnesia. In a specimen from the sin rocks at Cook's Point, the insoluble clayey portion equalled only 29.6 cent., and, as in the other case, one fourth of the soluble part consi of carbonate of magnesia.

Brick clay.

Brick Clay.—The stiff red clay which is so largely developed in valley of the second reach of the Kaminitiquia River would probably m

ry good common bricks. It is free from lime, but holds much iron, and therefore fusible. The lighter colored stratified clay of the lower reach also apparently suited for the same purpose, as well as the plastic clays ich have been described as occurring in the valleys of most of the rivers tering Lake Nipigon.

Building Stone.—Among the stones most suitable for building purposes, et with in the region explored, may be mentioned the sandstones occurring the peninsula between Thunder and Black Bays, along the lower part the Black Sturgeon River, east and south of Black Sturgeon Bay on ake Nipigon, at Nipigon House, and on the southern peninsula of mbabika; the limestone of Chief's Bay and Cook's Point; the feldspar-rphyry to be found along the shore from Nipigon House to English Bay; d some varieties of the common dark trap, in various parts of the region. Building stones.

Roofing Tiles.—The hard dark colored shales of the lower reach of e Kaminitiquia are supposed by some to be fit for roofing purposes, t owing to their want of strength, and their imperfect cleavage, they are t poorly adapted to such a use. On the east shore of Lake Nipigon, out three miles north of the Poplar Lodge River, Mr. McKellar reports, band of dark colored slate with very perfect vertical cleavage, which he inks might answer for a roofing material. Roofing tiles.

RAILWAY ROUTE AND COLONIZATION.

In the special report on the practicability of a railway through the Nipigon untry, which I had the honor of addressiug to you on the 22nd of ebruary last, a general description was given of the route which we dis-vered, and its advantages. Our map of the district having been com-led since that time, I am now enabled to indicate this route upon it. It osses the Nipigon at the outlet of Lake Helen, where the river is narrow, d the banks, consisting of boulder-drift, are from thirty to forty feet gh. From this intersection it follows down the western side of Nipigon arbor to a point about three and one-half miles south of Red Rock, here it turns westward through the level pass leading to Black Sturgeon iver. This river would be crossed at some point below Eshquanonwatan ake. Continuing north-westward, the route could pass either east or est of Pike and Cyclas Lakes, or between them. Further on, it would ross the Poshkokagan and the Kabitotiquia not far from Chief's Bay, at very moderate elevation above Lake Nipigon. Between the latter stream nd the valley of the Gull River the country is level. The general grade the above distance—about 100 miles—is very slight; Lake Nipigon, ccording to the observations which I have given in a previous part of this Railway route.

Railway route. report, being only a little more than 300 feet above Lake Superior ; v along the above route there appear to be no difficult local grades. Bes the rivers to be crossed, the only obstruction which I observed is a s point of rock on the west side of Nipigon Harbor, just before turning towards the Black Sturgeon River. This consists of a cliff of red n capped by trap, rising from the margin of the lake. The water at its is very shallow, some of the stones rising above the surface, and suffic of the rock to form an embankment could be easily dislodged from jointed columnar trap above. The whole length is only from fifty to hundred yards.

A practible route for a railway may possibly be found by following up west side of the Nipigon River, and the valley of Portage Brook, thence crossing to the Black Sturgeon River in the neighborhood of I quanonwatan Lake.

Waggon-road. For the immediate purpose of colonizing the shores of Lake Nipigo waggon-road might be constructed from Camp Alexander on the Nipi River, across to South Bay on the lake, the distance being not much o twelve miles. From this point, vessels on the lake would have acces upwards of 580 miles of coast-line, exclusive of the islands, many of wh are habitable.

I have the honor to be,

Sir,

Your very obedient servant,

ROBERT BELL

Montreal, May 23rd, 1870.

REPORT

ON THE

COALS AND IRON ORES

OF

PICTOU COUNTY, NOVA SCOTIA,

BEING AN APPENDIX

TO

REPORTS ON THE PICTOU COAL FIELD,

BY

MR. EDWARD HARTLEY, F.G.S.,

MINING ENGINEER TO THE GEOLOGICAL SURVEY.

The following Report will furnish information concerning the economic ilue of the coals of Pictou County, Nova Scotia, together with a notice ' some localities of iron ore likely to become of interest from their prox- iity to the Pictou coal-field ; these deposits of iron ore having received :amination during my field-work of the years 1868–69. It will be divi- ›d into three sections :—(I) Descriptions and analyses of Pictou coals ; I) Reports of practical trials of Pictou coals as steam and gas-produ- rs, and for other purposes of the mechanic arts ;—(III) Iron ores and eir occurrence in Pictou County.

I.

DESCRIPTIONS AND ANALYSES OF PICTOU COALS.

A number of published papers and reports contain analyses of coals m the Pictou region ; but with few exceptions, these publications are out print, or otherwise inaccessible to the general public. In this section it proposed to bring these scattered analyses together, supplementing them a series made by myself during the spring of 1869, in the laboratory of :. T. Sterry Hunt, F.R.S., chemist to the Survey, and a few more careful terminations made still later, in Dr. Hunt's laboratory, by his assistant, r. Gordon Broome, F.G.S., Associate of the Royal School of Mines.

Classification of analyses.

Analyses of coal may be divided into three classes; (a) practi analyses in the large way, or the determination of the proximate consti ents of the coal, that is, the moisture, volatile matters, coke and ash, burning a large quantity; (b) proximate analyses in the laboratory, or result of the drying, coking, and incineration of a few grains in a sm crucible; and (c), ultimate analyses, being the careful determination the ultimate elements of a coal or other fuel, such as carbon, hydrog oxygen and nitrogen; the class (c) being, of course, the most satisfact for calculations of the theoretical value of a coal.

Of the analyses now given, by far the greater number belong to second class, (b) in which may be included all those made in the Surv laboratory, as the great expense and amount of time necessary for th completion has rendered both practical and ultimate analyses out the question. Although far from satisfactory as accurate *measures* of true value of coals, the crudest analyses enable us to form some idea their character, and, in the absence of practical trials, furnish us w elements on which to base an approximate opinion as to what practi service they are best fitted to perform.

Method of analysis.

The method of analysis pursued in the examination of the samples coal obtained in the Pictou coal-field by myself, was somewhat as follov Drying in a water-bath at a temperature of 212° Fahrenheit, to ex moisture; heating to bright redness in a closed crucible to obtain the p centage of volatile combustible matter; and finally incineration in an o crucible to obtain the amount of ash. In most cases two different samp of each coal were examined, one being coked by a sudden application o high heat, to obtain the largest possible amount of volatile matter or *g* irrespective of its character, the quantity of coke being thus reduced t minimum; while in treating the second, the heat was applied with greatest care, and raised very gradually, by which treatment the ga obtained are more highly carburetted, and in smaller quantity than wl the heat is suddenly applied. In a few cases, determinations of sulp have been made, but from this impurity the greater part of the coals r worked in the Pictou region are quite free. The general very light col of their ashes attests their freedom, when properly selected, from sulphu combination with iron, as *pyrites*, and among the coals examined, the as of but few contain an appreciable amount of sulphate of lime, being ge ally very silicious or sandy in the best coals, and therefore not incline form a clinker adherent to the grate-bars. No full analysis of the as of any of these coals has yet been made, so far as I am aware.

Theoretical evaporative powers.

The calculations of the *theoretical evaporative power* of the different c analyzed, are based upon the fact, that in burning bituminous coals of class under consideration, in an ordinary furnace, such as has always b

used for comparing their results in steam production with those of anthracites and other fuels, the combustion of the volatile matters of the coal does not, in most instances, produce more than enough heat to effect their volatilization, and therefore *theoretically*, the value of the coals for steam purposes, depends on their content of fixed carbon, or the carbon remaining in their coke when the coal is heated in close vessels.*

The calculation may be made as follows:—Let the weight of coke, less ash, in parts of one unit of coal—that is, the percentage of fixed carbon—be expressed by C; the co-efficient of the heating power of carbon by c, and the co-efficient of the latent heat of steam at 212° F., by l,—then:— Method of calculation.

$$\frac{C \times c}{l} = x$$

x being the theoretical evaporative power of the coal, or the number of pounds of water which one pound of coal should evaporate from a temperature of 212° Fahrenheit, *theoretically*.

The values given to the co-efficients used, vary with different authors. To c—expressing the number of units of water which the combustion of one unit of pure carbon will raise 1° Fahrenheit—Regnault gives the value of 13,268, while by Dulong† it is given as 12,906. Values of co-efficients.

To the co-efficient l, Regnault gives the value 965.7°; while the experiments of Professor W. R. Johnson indicate for it a value as high as 1030°.‡

In my own calculations the values of Regnault have been used, although later experiments have shown a further modification,§ inasmuch as these values have been used in the Reports of the British Commissioners on the Naval Steam-Coal Enquiry,¶ with whose results a comparison will be most valuable, although in the American reports, (published before Regnault's Official reports on coals.

*Practical experiments have already shown that North Country (or Newcastle) coals, burnt in proper furnaces calculated to prevent smoke, give a practical evaporative effect higher than the theoretical power based on this supposition, and I hope to be able at some future time to show a similar result with our coals; but as, with an ordinary furnace, the method of calculation to be given approaches correctness, and more especially as I wish to compare the theoretical values of these coals with results obtained from experiments conducted some years since, I still, for the time, adhere to the old rule.

†Vide Comptes Rendus, tom. 7, page 871, et seq.

‡W. R. Johnson's Report on American Coals, 1844, p. 22.

§The late researches of Favre and Silbermann (*vide* Ann. Ch. Phys. (3) xxxiv, 357—xxxv. 15—xxxvii. 405.), and of Andrews (Phil. Mag. (3) xxxii. 321, 425), have slightly modified Regnault's values. For a full digest of their results, see the admirable article on FUELS, by Prof. B. H. Paul, in Watt's Chemical Dictionary, 1864, vol. II., p. 718, et seq.

¶Reports of Sir Henry T. De la Beche and Dr. Lyon Playfair to the Lords Commissioners of the Admiralty, on trials of coals, 1848 and 1852. See also Johnson's Coal Trade of British America, 1850, p. 78

exhaustive memoir* appeared,) the values of Dulong for c, and Johnso for l, have been adopted.

Value of theoretical results.

The results obtained by these different values do not differ as greatl from each other as they will be found to differ from actual results, and the are useful only in the absence of reliable practical trials. In coals of thi class, *i.e.* bituminous coals with 25 % to 35 % of volatile matter, thes theoretical indices are generally slightly higher than figures obtained fro furnaces of low-pressure boilers where no special arrangements are mad for "*smoke-consumption*"—as it is called, or more properly, smoke-preve tion, for smoke once formed cannot be consumed.

Values from ultimate analyses.

In cases where ultimate analyses are to be obtained, the theoretical valu of *all* the combustible matter in a coal may be obtained by the followin formula :—

$$\left(\frac{C \times 13268}{965.7}\right) \quad \left(\frac{H—h \times 62470}{965.7}\right) = x$$

in which C represents the entire carbon content, both fixed and volatil H the quantity of hydrogen in a unit of fuel, and h the quantity of hydr gen which will correspond to the oxygen in the coal; x expressing, before, the number of pounds of water theoretically convertible into stea from 212°, by one pound of coal, provided all the combustible constituen of the coal could be rendered available ; or, in a word, the highest possib evaporative power of the fuel under any circumstances.

Expression of mechanical force.

The values of x, as used in the two preceding formulæ, or an evapor tive value given by practical trial, may be converted into an expression mechanical force by the formula :—

$$(Wn) \times 965.7 \times 782 \doteq y,$$

in which W represents water, of which n pounds are evaporated by o pound of coal, (thus giving Wn the value of x in the preceding formulæ and y representing the number of *foot-pounds* of work theoretically possible.

*Regnault. *Relations des experiences entreprises * * * pour determiner les princ pales lois et les données numériques qui entrent dans le calcul des machines à vapeur. Par* 1847. See also a translation of the portion on the latent heat of steam at different pre sures, in the Works of the Cavendish Society, vol. I.

† This formula is deduced from the fact that n pounds of water, multiplied by 965.7°, or t co-efficient of the latent heat of steam at 212° F., indicates the number of pounds of wat which would be raised 1° Fahrenheit by the combustion of one pound of coal. T number 782 arises from experiments on the mechanical force denoted by the elevation temperature of a pound of water 1° F., that force being equal to 782 lbs. raised one fo high, according to the careful experiments of Mr. Joule on the friction of oil, water a mercury.—(Extract from Report of British Commissioners, from which the formula taken.)

Theory and practice.

It should be distinctly understood that no calculations based upon mere analyses can take the place of trials of the coals in the large way as steam and gas-producers, for smelting, heating iron, or for any other practical use; for though, as a rule, these theoretical values furnish us with a general idea of the use to which a coal is best fitted, it is of not unfrequent occurrence that theory and practice differ greatly. For further information on practical values of fuel, I would refer the reader to the works of Prof. W. R. Johnson, and to the second section of this Report.

COALS OF THE WEST SIDE OF THE EAST RIVER.

COALS FROM THE MAIN SEAM, ALBION MINES.

No favourable opportunity offered during my stay in this district for an examination of samples of the coal of the Main seam, which would enable me to satisfactorily separate the peculiar varieties of the different benches. I therefore reproduce the careful section prepared by Dr. Dawson, which well illustrates the character of all the different descriptions of coal of this seam.*

This section was prepared from an examination of a column of coal from the Main seam, extracted for the New York Industrial Exhibition of 1852 by Mr. Henry Poole, then manager of the Albion mines.

Dawson's section of the Main seam.

SECTION OF MAIN SEAM, BY DR. J. W. DAWSON.

		Ft.	In.
1.	Roof shale; vegetable fragments and attached *Spirorbis* (in specimen)	0	3
2.	*Coal*, with shaly bands	0	6½
3.	*Coal*, laminated; layers of mineral charcoal and bright coal; band of ironstone balls in bottom	2	0
4. Worked in Old Mines.	*Coal*, fine cubical and laminated; much mineral charcoal	3	2
5. Worked in Old Mines.	Carbonaceous shale and ironstone, with layers of coarse coal (*holing stone*), remains of large fishes and coprolites. This bed varies much in thickness	0	4½
6. Worked in Old Mines.	*Coal* laminated and cubical; coarse towards bottom	9	3
7.	Ironstone and carbonaceous shale in the coaly layers, and trunks of *Lepidodendron*, *Ulodendron*, *Sigillaria*, etc., all prostrate	0	8
8.	*Coal*, laminated as in No. 6; line of ironstone balls in bottom	1	2
9.	*Coal*, laminated and cubical; a few small ironstone balls; many vascular bundles of ferns in this and underlying coal	6	7
10.	Ironstone and pyrites	0	3
11.	*Coal*, laminated and cubical, as above	10	3
12.	*Coal*, coarse layers of bituminous shale and pyrites	1	0
13.	*Coal*, laminated, with a fossil trunk in pyrites	2	1
14.	*Coal*, laminated and cubical, with layers of shale passing downwards into black slickensided underclay, with coaly bands	2	3

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* Acadian Geology, second edition, pp. 331-32.

	Ft. In
15. Underclay, to bottom of specimen	0 10
Total	40 8
Vertical thickness	38 6

Coal of Main seam.

The general character of the coal from the Main seam is that of a higl bituminous caking coal, generally of a laminated structure, and showi much mineral charcoal on the planes of deposition. Although much im rity exists in the form of shale, ironstone, and arenaceous material car ing pyrites, these may be easily separated from the good coal in taking the different floors of the seam. The coal raised is also carefully examin at the shutes, any refuse or shale being thrown aside before the coal is into railway cars for shipment.

Specific gravity.

The specific gravity of this coal is stated by Dr. Dawson to be fr "1.288 (which is that of the best coal extracted,) to 1.447 (which is tha the coarsest coal that has been worked)."*

The mean specific gravity of six samples, taken from the top, middle bottom of the seam, in the central part of the mines, is stated, on the sa authority, as 1.325, which agrees exactly with the result of some tr made for the American Government, by Prof. W. R. Johnson, wh researches will receive attention in the second section of this Appendix

The following, being an abstract of the statements of Dr. J. W. Daw in his Acadian Geology, is extracted from Prof. How's late work on Mineralogy of Nova Scotia, published by authority of the Provincial G ernment :—

" Numerous analyses were made by Dr. Dawson in 1854, shewing character of the Albion Mines coal from different parts of the upper f of the mine, and also the varieties existing throughout the whole thickn of their Main seam, in a series of assays of coals taken at distances of foot in thickness. The general results were that the best coal was fo on the N. W. side of the old workings, deterioration taking place at eit extremity of the workings of the upper floor. In all parts of the mine lower coal was inferior to that of the middle of the seam, and still more to that of the upper part (above the " holing stone"), or " fall coal" of miners. On the west, this fall coal disappeared, or was reduced to insi ficant thickness. The assays made to show the variations in thickness the whole seam were on coal taken at this western part. This valu series of assays of the coal of this seam, so familiar to the world, is h given.

* Acadian Geology, p 333.

Assays of Samples taken at the distance of one foot in thickness in the Main Seam of coal of the Albion Mines, Pictou, by Dr. Dawson. Dawson's analyses.

	Volatile by rapid coking.	Volatile by slow coking.	Fixed carbon.	Ashes.
1. Coal	26·0	19·9	63·8	16·3
2. do	27·8	24·1	63·8	12·1
3. do	27·4	25·7	60·0	14·3
4. do	27·2	25·0	65·5	9·5
5. do	25·8	25.1	64·8	10·1
6. do	25·2	24·9	62·5	12·6
7. do	27·4	22·0	68.5	9·5
8. do	26·8	22·9	66·7	10·4
9. do	27·0	23·9	61 3	14·8
10. Carbonaceous shale	16·4	15·9	26·3	58·8
11. Coal	28·8	25·8	59·7	14·5
12. do	27·2	25·4	62·5	12·1
13. do	27·6	24·7	62·5	9·8
14. do	26·6	23·9	61·0	15·1
15. do	26·8	23·1	65·1	11·8
16. do	28·8	24·9	62·3	12·8
17. do	30·4	26·0	65·0	9·0
18. do	26·0	26·1	63·0	10·9
19. do	26·0	25·0	66·3	8·7
20. do	26·8	22·7	63·6	13·7
21. Coarse coal	25·8	23·3	58·3	18.4
22. do	27·2	22·5	60·3	17·2
23. Coal	29·4	22·6	64·3	12·1
24. Coarse coal	25·8	22·4	57·6	20·0
25. do	25.8	23·1	60·2	16·7
26. do	27·8	21·9	54·8	23·3
27. Coal	27·0	24·3	65·5	10.2
28. do	25·6	22·4	65·0	12·6
29. do	25·8	22·7	62·7	14·6
30. do	27·2	23·1	67·4	9·5
31. do	32·6	22·4	66·5	11·1
32. Coarse coal	22·2	21·5	50·4	28·1

"The coal above the "holing stone" is not found at the part from whence ese coals were taken, as before explained. At the N.W. side of the old rkings it is three feet thick, and has this composition :—

	Dawson.
Moisture (hygroscopic water)	1.550
Volatile combustible matter	27.988
Fixed carbon	60.837
Ash	9.625
	100.000

"In these assays we have a most instructive and interesting set of experi- ents, the most complete of the kind, so far as I know, ever made on any d of coal of considerable thickness. 'All the coals afford a fine vesicular

coke, and their ashes are light-gray and powdery, with the exceptic those of the coarse coals, which are heavy and shaly. The worst de of this coal is its containing rather a large quantity of bulky ashes, w causes it to be less esteemed for domestic use than, on other ground deserves. It is very free from sulphur, burns long, and with a great duction of heat, and remains alight, when the fire is low, much longer most other coals.' "*

Foord-pit coal. These analyses, it will be seen, are of coals from the older working the Crushed mines and Dalhousie pits. Of the coal obtained from the Foord pits, I have made the following analyses :—

	HARTLEY.	
	By fast coking.	By slow cokin
Hygroscopic water,	1.73	1.80
Volatile combustible matter	28.18	25.12
Fixed carbon	62.94	65.70
Ash (light-gray)	7.15	7·38
	100.00	100.00
Coke	70.09	73.08
Theoretical evaporative power	8.62 lbs.	9.03 lbs.
Sulphur (in average of coal)		0.32 per

The specimens analyzed were hand-samples from the bank at the F pits, and believed to fairly represent the whole mass, which suppositi confirmed by the agreement of my assays with the following analysis Prof. How, of King's College, Windsor, Nova Scotia, of a sample of barrel, sent him by Mr. Hudson, Chief Manager of the General Mi Association.

How's analysis. " *Coal from Foord pits, Main seam.* An average of the large sa sent, gave :—

	How.
Moisture	1.48
Volatile combustible matter	24.28
Fixedcarbon	66.50
Ash	7.74
	100.00
Coke	74.24
Sulphur	0.55
Theoretical evaporative power	9.13 lbs.
Specific gravity, average of three specimens	1.294

" It follows that this is, for various reasons, a valuable coal. The vol combustible matter is such in amount and character as to promise we

*H. How, Mineralogy of Nova Scotia, p. 18--20.

as-making. The coke is firm and abundant, and the high theoretical evapo-ative power, shewing the number of pounds of water which one pound of oal ought to evaporate from a temperature of 212°F., (rather above the ractical average of 37 Welsh coals), places the coal very high as a steam-roducer. The amount of sulphur is decidedly low, obviously an import-nt fact as regards domestic use, gas-making, and preservation of grate ars. The coal lights up readily in a parlour stove, cakes moderately, and ives a hot lasting fire; the ash is nearly five per cent. less than in coal om the same seam examined by Prof. Johnson, in 1842–43, and one or wo per cent. less than coal from the *best parts* of the seam, tested by Dr. awson, in 1854. This is an important feature, as the large quantity of ght bulky ash was then considered the worst defect of the coal. The ash onsists chiefly of sandy matters; there is so little lime that there will be ut little tendency to form clinkers. The specific gravity is high enough show good storage character. One cubic foot broken for use should weigh bout 52½ lbs., and one ton of 2,240 pounds should occupy, in the same ate, about 42½ cubic feet space in storage.

"From its hardness, and the appearance of the contents of the barrel after bout 100 miles of railway carriage, I conclude that the coal would bear andling and land-carriage without making much *small*, or dust."*

These remarks and analyses comprehend all that can be theoretically said f the value of the Foord-pit coal. I may, however, state that the coke om this coal is of exceptionally good character, and though all the coals om this seam furnish good coke, that from the Foord-pit coal seems to ke the first rank, from its coherent and yet very porous texture. It is ery light, of a silvery-gray colour, and a metallic lustre.

COALS FROM THE DEEP, OR CAGE-PIT SEAM, ALBION MINES.

In general appearance, the coal of the Deep seam much resembles at of the Main. A section of the different beds of this seam was exam-ed by Dr. Dawson, in 1854, of which he publishes the following descrip-on, with assays of the different beds.† Deep-seam coal.

SECTION OF DEEP SEAM, BY DR. J. W. DAWSON.

Dawson's section of the Deep seam.

1. Gray argillaceous shale (roof).
2. Tender laminated coal; much mineral charcoal.
3. Laminated compact coal; less mineral charcoal.
4. Laminated compact coal; less mineral charcoal.
5. Carbonaceous ironstone, crusts of *Cyprids*.

*Extract from letter of Prof. H. How, of King's College, (late chemist to the British dmiralty Coal Enquiry), to James Hudson, Esq., G.M.A.

†Acadian Geology, p. 335–336.

6. Laminated compact coal; much mineral charcoal.
7. Laminated coarse coal.
8. Laminated compact coal.
9. Laminated coarse coal.
10. Laminated compact tender coal.
11. Laminated compact coal.
13. Laminated compact hard coal.
14. Laminated compact hard coal; thick layer of mineral charcoal.
15. Laminated compact coal.
16. Laminated compact coal; much mineral charcoal.
17. Laminated compact coal; much mineral charcoal.
18. Shaly coal; impressions of plants.

The results of assays of the above samples of coals taken, at distan
of one foot, in the Deep seam are given in the following table:—

Analyses.

		Dawson.			
		Volatile by rapid coking.	Volatile by slow coking.	Carbon fixed.	Ash
2.	Good coal	24.8	21.0	67.6	11.4
3.	Good coal	25.2	25.2	67.3	7.5
4.	Good coal	28.4	23.9	70.8	5.3
5.	Ironstone and coal	26.8	27.5	18.5	54.0
6.	Coarse coal	23.2	20.5	59.1	20.4
7.	Coarse coal	23.6	20.4	48.0	31.6
8.	Good coal	26.2	22.4	70.3	7.3
9.	Coarse coal	25.2	21.1	49.3	28.6
10.	Good coal	24.8	20.4	68.9	10.7
11.	Good coal	24.8	22.3	64.3	13.4
12.	Coarse coal	23.4	20.5	51.2	28.3
13.	Coarse coal	23.0	20.1	55.3	24.6
14.	Good coal	27.4	23.9	68.1	8.0
15.	Good coal	29.0	22.9	71.5	5.6
16.	Good coal	26.8	21.9	69.6	8.5
17.	Good coal	24.6	19.9	63.8	16.3
18.	Shale and coal	17.6	21.1	23.0	55.9

Coal now worked.

The following analysis of a small sample of the coal now being wo
at the western face, has been made by Mr. Broome:—

	Broome. Coking.	
	Rapid.	Sl
Volatile matter	28.1	2
Coke	71.9	7
	100.0	10

Hygroscopic water	1.
Volatile combustible matters	25.
Fixed carbon	61.
Sulphur	.
Ash	10.
	100.
Specific gravity	1

The ash from this sample contained 75 per cent. of matter insoluble in 'drochloric acid, which was chiefly aluminous silicate. Iron was esti-ated in the soluble portion, which, by the volumetric method, gave of etallic iron equal to 2.762 per cent. of the ash. Supposing all the iron exist in this coal as pyrites, this amount would correspond to 0.4243 per nt. of sulphur in the coal. As experiment gave a larger proportion, it is ident that some of the sulphur present exists as a sulphate, probably of ne. The ash was gray, with a faint tinge of pink. This colour of ash usual with the coal of this seam. Coke, by rapid carbonization, hard; slow coking, a pulverulent mass was obtained. Character of ash.

To this analysis may be added the results of Prof. How, from an exami-tion of a large sample; probably a better average of the whole seam an the specimen examined by Mr. Broome:—

" *Coal from Deep, or Cage-Pit Seam.*—An average of the large mple sent, (one barrel), gave :— How's analysis.

	How.
Moisture	2.54
Volatile combustible matter	20.46
Fixed carbon	68.50
Ash	8.50
	100.00
Coke	77.0
Sulphur	1.69
Specific gravity (average of three specimens)	1.345
Theoretical evaporative power	9.41 lbs.

" This is an excellent coal, especially for domestic and steam purposes. s compared with that of the Foord pit, it gives a larger quantity of coke, d its theoretical evaporative power is decidedly higher, so that it must ove a valuable steam coal. It burns well in a stove, affording a strong during heat; its ash not being much above that of the Foord-pit coal, will also be found superior for domestic uses to the coal formerly raised your mines. The sulphur is not high, as compared with many coals, ough it is rather above the average of that in Welsh steam coal.

" The ash is chiefly sand; there is very little lime, so there will not be ich clinker formed. From the high specific gravity, one cubic foot of e coal should weigh about 53 lbs., when broken, and a ton of 2,240 lbs. ould be stored in about 42 cubic feet.

" The coal is harder and less easily broken than that from the Foord pit."*

* Extract from a letter from Prof. How to James Hudson, Esq., G.M.A.

COALS OF THIRD AND PURVIS SEAMS, ACADIA MINES.

Third and Purvis seams.

These seams are now abandoned, and no analyses have been mad the coal from them, as no samples lately taken from the seam c be procured.

COAL OF THE MC GREGOR SEAM, ACADIA MINES.

The following extract is from the Report of Mr. Hoyt to the Ac Coal Company, 1866 :—

McGregor seam.

"It has been found that the thickness of this coal (the McGr seam) increases as we progress westwardly, but diminishes as we wo the east.* The same remark will also apply to the quality of the At present, only the upper divisions of the seam are worked. The tom coal, which is of a coarse nature, is unsaleable, but would be suitable for iron-smelting†; and in case of the developement of the deposits on the East River of Pictou, a good market would be create it. The slaty band, between the top benches, is a source of much i venience and expense in mining; and with all the care exercised in ing, this foreign matter will, to some extent, get mixed with the good which is thereby injured in character for gas purposes.

"The quantity of ash produced by the two top benches pre a marked contrast in the character of the coals, as will be seen by th lowing analyses, which have been obtained from the former proprietor J. D. B. Frazer :"‡

Analyses.

	First bench.	Second
Volatile matter	22.50	23.3
Fixed carbon	65.70	70.0
Gray ash	11.80	6.7
	100.00	100.0
Coke	77.50	76.7
Specific gravity	1.334	1.3
From these analyses the theoretical evaporative power would be	9.03	9.6

This coal cokes well when the better portions of the seam are sele A very large amount of iron pyrites exists in the slaty portions o seam, which, if not most carefully removed, makes the coal worthless gas coal. Careful attention in hand-picking, will probably obviate objection to the coal.

* See p. 96 of my Geological Report.

† I have not analysed this coal from the bottom of the McGregor seam, but it a to contain too much sulphur and ash to be very suitable for iron smelting.

‡ Name of analyst unknown to me.

e theoretical evaporative power resulting from the second analysis given is large; it should render the coal a good steam coal, if the es were removed.

COAL AND OIL-COAL FROM THE STELLAR SEAM.

page 70 of the Geological Report, it is stated that the Stellar coal of the Acadia mines has the following section:— Stellar oil-coal seam.

Section.

	Ft.	In.
Good coal	1	4
Stellar oil-coal	1	10
Bituminous shale	1	10
	5	0

ese three divisions of the seam are quite separate and distinct in cter. The substances from each were examined some time since by How, who first described the peculiar substance forming the middle, to which, from a likeness in some of its qualities to the so called als, torbanite and albertite, he has given the name of stellarite, its throwing off sparks or stars of fire when lighted. From the three es Prof. How obtained the following results:—* Divisions of stellar seam.

Analyses.

	Coal.	How. Stellarite.	Shale.
olatile matters	33.58	66.56	30.65
xed carbon	62.09	25.23	10.88
sh	4.33	8.21	58.47
	100.00	100.00	100.00
oisture		.23	
ecific gravity		1.103	

al. The coal appears to be merely an ordinary fat caking-coal, with usually small percentage of ash for this region, but the bench being he value of the seam depends principally on the two lower divisions, rite, and oil-shale. Coal bench.

llarite. This peculiar substance was first known and worked at these by the former owner, the late Mr. J. D. B. Frazer, of Pictou. It rs to be an earthy bitumen, or, to quote Dr. Dawson, "a fossil swamp- or mud," † which he has elsewhere‡ shown, is the character of the y bitumens and highly bituminous shales of the coal formation gene- Stellarite bench.

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w, Mineralogy of Nova Scotia, p. 24.
adian Geology, p. 339.
e Dawson, "*On the conditions of accumulation of coal.*" Journal Geol. Soc. xxii. p. 95

Oil-shale bench.

Bituminous shale or oil-shale. This is a rather heavy brow black shale. The following analysis and remarks thereon, include this bench and the stellarite.

The first series is taken from Mr. Hoyt's Report to the Acadia Company for 1866. Analyses under the heading of No. 1 refer to larite, No. 2 to the oil-shale :—

Analyses for oil, etc.

	Wallace.* No. 1.	Wallace.* No. 2.
Volatile matters	68.38	38.69
Fixed carbon	22.35	8.26
Ash	8.90	52.20
Sulphur	.05	.25
Moisture	.32	.60
	100.00	100.00
Specific gravity	1.079	1.568
Weight per cubic foot	67½ lbs.	97
Crude oil per ton	126 gallons.	63 ga
Gravity of oil	.844	.850
Coke, per cent	31.25	60.46
Ash in the coke of stellarite, 28.48 per cent	....	....

	Penny.† No. 1.	Penny.† No. 2.
Volatile matter	67.26	34.16
Fixed carbon	24.03	12.30
Ash	8.40	52.00
Sulphur	.11	.74
Water	.20	.80
	100.00	100.00
Specific gravity	1.069	1.612
Weight per cubic foot	66¾ lbs.	100
Crude oil per ton	123 gals.	60
Gravity of oil	.844	.850

QUANTITY OF OIL BY VARIOUS TRIALS.

	(p
(1) Trial by J. De W. Spurr, St. John, New Brunswick, (No. 2) crude oil	74
(2) " by J. Howarth, Boston, Mass., by steam process, crude oil.	65
(3) " by F. Macdonald, Portland, Maine, (No. 2), crude oil..	50

Comparison with other oil-coals.

For comparison, the following results from these and other oil-coa introduced ; the table is taken from How's Mineralogy of Nova Scot

* Prof. Wallace, of Glasgow, Scotland.

† Prof. Penny, Andersonian University, Glasgow, Scotland.

	Crude oil per ton.
Union oil-coal of West Virginia affords	32 gals.
Elk River " " " " "	54 "
Kanawha " " " " "	88 "
Leshmahagow cannel, Scotland "	40 "
Albertite, New Brunswick,	92 to 100 "
Torbanite, Scotland,	116 to 125 "
Stellarite,	53 "
" No. 2 (shale)	50, 60¾, 63, 65, 74 "
" No. 1,	123 to 126 "
" picked samples gave in Boston	199 "

practical working at the Frazer mine the result was about 60 gallons ude, and from 30 to 35 gallons of fine clarified oil to the ton.

will be noted that the three oil-coals, or bitumens, known as tor-te, albertite, and stellarite, in the list just given, appear to afford the results in oil-manufacture. It will, therefore, be of interest to com- full analyses of these three, forming a class by themselves, and again mpare this class with other mineral combustibles from which they r to a greater or less extent. This subject has been thoroughly inves-ed by Prof. How, and the following tabulation of analyses, and con-ons drawn therefrom, are taken from his late work. Although most opriately introduced here, many of the facts will be found useful for parison with coals of other seams, and the remarks on the theoretical e of fuels is also of general interest.

Dr. How's remarks on oil-coals.

Having, on account of my former connection with the British Admi- Coal Enquiry, been one of those engaged to furnish chemical evi-e in the famous first trial in Edinburgh of the question whether the ral known as "Boghead coal," found at Torbane Hill, Linlithgow-, should properly be called a coal, I was naturally much interested on liscovery of the stellar oil-coal, and got ultimate analyses made of it and e "Albert coal," also the subject of a trial on the ground that it had improperly called coal. These analyses were very kindly made for hrough Prof. Anderson of Glasgow, who generously met my deficiency ne necessary apparatus, which I had not brought out with me. The lts were most interesting, especially when compared with those obtained bituminous and cannel coals. As to the former, I selected from e I had made in the Admiralty Enquiry, analyses of English, Scotch, Welsh bituminous coals, and as to the latter, analyses of English and ch cannels made by other chemists. The following table shews the rences which obtain between these minerals in proximate and ultimate ysis, and in specific gravity, and the ratio existing between the two important constituent elements :—

Mineral.	Locality.	Specific gravity.	Proximate analysis. Volatile matters.	Fixed Carbon.	Ash.	Ultimate analysis. Carbon.	Hydrog.	Nitrogen.	Sulphur.	Oxygen.	Ratio of carbon to hydrogen.	
Welsh bituminous coals.	Duffryn..........	1.326	15.70	81.04	3.26	88.26	4.66	1.45	1.77	0.60	100: 4.82	H
	Newydd	1.310	25.20	71.56	3.24	84.72	5.76	1.56	1.21	3.52	100: 6.79	
	Ebbw Vale	1.275	22.50	76.00	1.50	98.79	5.15	2.16	1.02	0.39	100: 5.73	
Scotch bituminous coals.	Grangemouth....	1.290	43.40	53.08	3.52	79.85	5.28	1.35	1.42	8.58	100: 6.61	
	Fordel...........	1.025	47.97	48.03	4.00	79.58	5.50	1.13	1.46	8.33	100: 6.93	
English bituminous coals.	Broomhill	1.025	40.80	56.13	3 07	81.70	6.17	1.84	2.85	4.37	100: 7.55	
	Lydney	1.283	42.20	47.80	10.00	73.52	5.69	2.04	2.27	6.48	100: 7.73	
Eng. cannel.	Wigan......... ..	1.276	39.64	57.66	2.70	80.07	5.53	2.12	1.50	8.08	100: 6.90	V
Scotch cannels.	Lesmahagow.....	1.251	56.70	37.26	6.03	73.44	7.62	....	1.14	*	100: 10.43	M
	Capledrae	.....	.....	.....	25.40	56.70	6.80	1.90	0.35	8.80	100: 11.99	A
Torbanite.	Torbanehill, Scotland.......	1.170	71.17	7.65	21.18	66.00	8.58	0.55	0.70	2.99	100: 13.00	H
Albertite.	Hillsboro, New Brunswick	1.091	54.39	45.44	0.17	87.25	9.62	1.75	....	†	100: 11.02	S &
Stellarite.	N. Glasgow, Nova Scotia....	1.103	66.53	25.23	8.21	80.96	10.15	0.68	....	‡	100: 12.53	

* Nitrogen and oxygen 11.76. † Sulphur (if any) and oxygen, 1.21. ‡ N, S, and oxygen .68.

" In the paper in question I pointed out that the true comparative v
of combustible minerals, while partly indicated by the relative amoun
volatile matter and fixed carbon, is only truly shewn when account is t
of the oxygen ; which is sometimes large in quantity, as is seen above,
is reckoned as volatile matter, to the credit of the mineral, while its
effect is reduction of value. I showed that when the hydrogen equ
the oxygen present is deducted, taking only those cases where there
apparent equality in the ratio of carbon to hydrogen, the last three min
in the table above, stand apart from the rest, thus :—

Ratio of carbon to hydrogen after deducting hydrogen equal to oxygen present.

Cannel coal from Wigan..................................	100 to 5.6
" " " Leshmahagow..........................	100 to 8.7
Capeldræ..........................	100 to 10.0
Torbanite from Scotland..................................	100 to 12.4
Albertite " New Brunswick..........................	100 to 10.8
Stellarite " Nova Scotia................................	100 to 12.4

* Allowing two per cent. for nitrogen.

and that theoretically they should be excellent ' oil-coals,' as is abund
shewn by experience."*

Description of stellar seam.

The size of the stellar-coal bench in the oil-coal seam varies
our or five inches in thickness to some two feet, and its conte
oil varies also. As a rule, this seam appears to improve going eastw
as stated by Mr. Hoyt. The general appearance of the stellar co
peculiar ; it is irregularly bedded, the different layers seemingly i
laced, giving it a sort of an entangled appearance, or a structure

* How, Mineralogy of Nova Scotia, p. 25–26.

lt. Sometimes the layers are much curved, and have smooth surfaces ꞏe slickensides, which appear to have been produced by lateral move- ꞏnts, corresponding very nearly with the plane of the bed, rather than by rtical motion, the better portions generally possessing this peculiarity, ꞏence the statement in many notices of this substance that the *curly* oil- al is the best. The surfaces of these curved faces have a bright, resin- s lustre, and a brownish-black colour, while a block sawn across shews a iform *dead*-brown surface. It breaks with a splintery fracture, very egularly, but approximately with the surfaces of deposition; the streak s a brown colour and a dull resinous lustre.

A large splinter of this mineral may be easily lighted with a match, and rns with a very bright, carbonaceous flame, throwing off sparks like ꞏrs, (whence the name), and leaving but a small amount of coke, from ꞏich, on burning off the fixed carbon, a grayish-white ash is obtained. ꞏrther remarks on the use of this mineral in gas-making, will be found in ction II of this Report.

COAL OF THE ACADIA SEAM, ACADIA COLLIERY.

Acadia steam coal.

ACADIA STEAM COAL. The principal value of this coal, is (as its name licates) as a steam-coal, though a portion of the seam at this colliery ꞏy be suitable for gas-making. As the character of the coal as a steam- ꞏducer will receive the fullest attention in the second section of this ꞏport, it has been deemed unnecessary to make any analyses of it as t, though when time permits I hope to obtain a full series of analyses of ꞏ coals from different benches of the seam, by examination of a series of ꞏcimens presented by Mr. Hoyt. In the meantime I offer my practical omotive and steamer-trials, with some other tests of considerable interest, Section II, which I consider will give abundant evidence of the excel- ꞏce of the Acadia steam-coal.

Third bench.

Only one analysis of this coal has been made in the laboratory of this rvey, that of samples of the coal taken from the third bench, or the ꞏr feet immediately underlying the fireclay parting. (See page 97 of my ological Report.) These specimens were selected for analysis, because I ieve this bench to be better fitted for gas purposes than the rest of the ꞏm, being apparently the softest coal afforded by the Acadia seam at s colliery.

The analysis has lately been made by Mr. Broome, with the following ults :—

Analysis.

	Broome. Coking. Rapid.	Slow.
Coke	65.12	68.70
Volatile matters	34.88	31.30
	100.00	100.00

Hygroscopic moisture..	2.100
Volatile combustible matter....................................	32.274
Fixed carbon..	57.570
Sulphur..	.506
Ash, (pinkish white)...	7.550
	100.000
Specific gravity...	1.32

The coke by rapid carbonization was firm, but by slow heating a verulent mass was obtained.

This analysis shows that a portion of the seam at the Acadia colliery coke well, and that it contains sufficient volatile matter to make a coal. The greater part of the seam is a much harder coal than the speci examined, and, when all the benches are mixed, does not coke satisfacto in open heaps, and is therefore sold only as a *free-burning* or steam-c Were it desirable, however, I think the third bench could be easily s rated in the working of the seam.

The coal of this seam is rather more compact in appearance than from the Main at the Albion mines, and shows but little mineral char on the deposition-planes. The cleat planes and cross fractures of the are usually very brilliant, and do not show the laminæ or deposition-pl very clearly.

COAL OF THE ACADIA SEAM, DRUMMOND COLLIERY.

Drummond coal.

From a careful examination of the different benches of coal in the w ing, and subsequent examinations of a series of large samples of the c presented by Mr. Dunn, manager of the Intercolonial Coal Company, enabled to present the following description of this fine seam of coal worked at the Drummond Colliery. With my description of the benc analyses will be given, forming what I believe to be the most careful complete series of assays ever made of different benches of any seam of siderable thickness. These analyses have lately been made in the Su laboratory by Mr. Gordon Broome, F.G.S., chemical assistant to D Sterry Hunt, chemist and mineralogist to this Survey.

Description of seam worked.

Description and analyses of the benches of the Acadia seam at Drummond Colliery, Pictou County, Nova Scotia.

Roof-shale.

Roof-shale; black, highly carbonaceous shale, giving a dark b streak, and containing *Spirorbis* and *Cythere* shells, with *Antholites, L dodendron, Lepidostrobus,* not specifically determined, and *Cordaites b sifolia.*

Top coal.

1. *Top coal;* not taken out in the workings. This is left in as a sup for the roof. Coal good, principal partings show mineral charcoal, and

ther a dull lustre. On cleat surfaces the general lustre is brilliant, but e laminæ of deposition show plainly in lines of brilliant and dead black. ıe joints are rather irregular, generally inclined about < 80° to 85° to the position-planes, but the surface next to the lower parting, (*a smooth irting*,) shows two regular sets of joints at right angles, giving the coal *cubical* appearance.

Thickness of *top-coal* bench, 2 feet, 6 inches.

ANALYSIS NO. 1; TOP COAL.

Analysis.

Volatile at 100 C., (moisture)	.72
Volatile at 220° C.,	7.83
Total volatile, 1. By slow coking	27.56
" " 2. By fast coking	30.19
Coke, 1. By slow coking	72.44
" 2. By fast coking	69.81
Volatile matter	29.928
Fixed carbon	60.350
Ash, (gray)	9.460
Sulphur	.262
	100.000
Specific gravity	1.309

Fall coal.

2. *Fall Coal;* immediately above the fireclay parting, or *holing*, this ›ing the first bench taken down. Coal good; surfaces of deposition show ›ad-black patches of mineral charcoal, with bright points, and patches of ›ight bituminous matter. Cleat surfaces brilliant, the joints running in ›o systems, giving this bench in some parts of the workings, a cubical, or › it is technically called, *dicey*, structure. The surfaces of one system of ›ints show oblong or oval scars, as of *shrinkage*, while of the second system ›e surfaces are quite regular and brilliant.

Thickness of *fall-coal* bench, 3 feet, 3 inches.

ANALYSIS NO. 2; FALL COAL.

Analysis.

Volatile at 100° C., (moisture)	1.56
Volatile at 220° C	13.61
Total volatile, 1. slow coking	29.78
" " 2. fast coking	31.92
Coke, 1. slow coking	70.22
" 2. fast coking	68.08
Volatile matter	31.694
Fixed carbon	60.320
Ash (gray)	7.560
Sulphur	.426
	100.00
Specific gravity	1.328

First bench.

3. *First bench;* (below the holing.) Coal good; all of the surfac whether of cleat and fracture, are brilliant, and the deposition-planes sh very little mineral charcoal. The joints are irregular in direction a angle, cutting the coal up into oblique prisms. This is a remarka clean and bright coal.

Thickness of *first bench,* 4 feet.

ANALYSIS NO. 3; COAL OF FIRST BENCH.

Analysis.

Volatile at 100° C., (moisture)	1.80
Volatile at 220° C	16.45
Total volatile, slow coking	26.49
" " fast coking	34.11
Coke, slow coking	73.51
" fast coking	65.89
Total volatile matter	33.526
Fixed carbon	55.390
Ash, (gray)	10.500
Sulphur	.584
	100.000
Specific gravity	1.327

Second bench.

4. *Second bench;* (so marked in specimens sent me.*) Good co laminated and cubical; in some parts of the seam the cubical structure very distinct. On the surfaces of the deposition-planes, there is so mineral charcoal, but all the other surfaces are of a brilliant black.

ANALYSIS NO. 4; COAL OF SECOND BENCH.

Analysis.

Volatile at 100° C., (moisture)	1.31
Volatile at 220° C	14.61
Total volatile, slow coking	28.73
" " fast coking	31.02
Coke, slow coking	71.27
" fast coking	68.98
Total volatile matters	29.973
Fixed carbon	60.310
Ash, (gray)	8.670
Sulphur	1.047
	100.000
Specific gravity	1.343

Third bench.

5. *Third bench;* the lower two feet of good coal, next above the coa coal; forming the bottom of the seam. Coal good, laminated distinctly ; is not so bright as the first and second benches, though an excellent co Deposition-planes are a dull black, showing much mineral charcoal. Cl

*In my Geological Report, p. 100, I have associated this bench with the one below which is now called the third bench.

nes show laminæ of deposition plainly, and in the joints, in many cases, e seen scales of calc-spar.

ANALYSIS NO. 5; COAL OF THIRD BENCH.

Analysis.

Volatile at 100°C., (moisture,)	1.43
Volatile at 220°C	13.12
Total volatile, slow coking	29.14
" " fast coking	31.32
Coke, slow coking	70.86
" fast coking	68.68
Total volatile matters	30.756
Fixed carbon	59.890
Ash (gray)	8.790
Sulphur	.564
	100.000
Specific gravity	1.335

6. *Coarse-coal bench*, bottom of seam; thickness about 2 feet, 9 inches. al coarse and shaly; deposition-planes show uniform dead-black surfaces. al breaks with irregular fractures in all directions, giving fracture faces of a dull lustre and brownish black colour. Not worked. Coarse-coal bench.

ANALYSIS NO. 6; COAL OF THE COARSE-COAL BENCH.

Analysis.

Volatile at 100°C., (moisture)	1.58
Volatile at 220°C.,	undet.
Total volatile, slow coking	29.89
" " fast coking	31.81
Coke, slow coking	72.44
" fast coking	69.81
Total volatile matters	32.81
Fixed carbon	37.16
Ash, (red)	31.03
Sulphur	undet.
	100.00
Specific gravity	17.65

The cokes of Nos. 1, 2, 3, 4, 5, obtained by the carbonization of the al in the small way, (in a crucible), were all strong and light, whether slow or rapid heating, though of course more compact with a slow carization. When heated rapidly the coke swells greatly, and is of a very-gray colour and metallic lustre. All these benches should, if operly managed, furnish an excellent coke in the large way. With the gle exception of the Foord-pit coal, no coal from this region which I ve examined has given as good a coke in the crucible. The coke from o. 6, or coarse coal, is soft and brittle. Cokes.

The amount of ash in the different samples is lower than the average Ash.

of Pictou coals, and the sulphur-content is, in samples I., II., IV., decidedly low. The coal of the second bench appears to give the great amount of sulphur, being somewhat over the average of the best We coals, but in the coal of the whole seam, when mixed together, the amou of sulphur will be found to be exceptionally small.

Drummond coal for gas-making.

From the amount of volatile matter, as shown by these analyses, th coals, (*i. e.* the good coals of the seam,) should all belong to the class gas-coals; in the first bench, No. 3, the content of volatile matter is v large, and about equal to the average of Newcastle coals, when rapi carbonized. A reference to the report of Mr. Thompson, of the Pic gas-works, on this coal, (which is published in Section II of this Repor will show that in this case the conclusions of theory agree with practi results.

With regard to their use as steam-producers, theory gives the follow indices of their evaporative powers:—

Theoretical evaporative powers.

I.	Fixed carbon	60.35	per cent	= 8.29	lbs. water	to 1	of coal.
II.	"	60.32	"	= 8.29	lbs.	"	"
III.	"	55.39	"	= 7.61	lbs.	"	"
IV.	"	60.31	"	= 8.29	lbs	"	"
V.	"	59·89	"	= 8.27	lbs.	"	"

It will be seen that a remarkable uniformity exists between the coals I., II., IV., V., and that their theoretical evaporative powers are rath high for coals of this class, while III. falls rather below the average fixed carbon. In this connection, however, I would draw attention to fact that coals of this class are now burnt so as to give an evaporat power considerably above the theoretical index calculated from the fi carbon of the coal alone. This subject has already been incidenta referred to in the introduction to this Section,* and will also rece special attention in Section II.

COAL OF THE ACADIA SEAM FROM THE NOVA SCOTIA COLLIERY.

Nova Scotia Co.'s Coal.

A section of this seam, giving details of the character of the coals of different benches, has been included in the Geological Report, † and following analyses of three specimens of the coal, by Prof. B. Silliman, Yale College, New Haven, Connecticut, have been sent me by Mr. F. Northrop, Secretary of the Nova Scotia Coal Company:—

Silliman's analysis.

	SILLIMAN.		
	(1) Top.	(2) Middle.	(3) Bott
Volatile matters	32.68	32.39	33.4
Fixed carbon,	62.08	62.40	61.4
Ash	5.24	5.21	5.1
	100.00	100.00	100.0

* See note on North Country coals, page 3.

† Pages 103-104 of the Geological Report.

rom these analyses the theoretical evaporative power of the different
ples would be :—

No. 1, 8.53 lbs. ;—of No. 2, 8.57 lbs. ,—of No. 3, 8.44 lbs.

n the letter accompanying these analyses, Prof. Silliman makes the
wing statements :—

The coke is firm and strong, while the ashes are light coloured, and so
ly free from oxide of iron as to warrant the belief that they will not
much clinker when the coal is used in a furnace. The amount of
hur in the coal was not determined, as the quantity is too slight to
ler an experiment in the small way of any practical value."

; would appear from these analyses that there is a change in the char- Change in the Acadia seam.
r of the coal of the Acadia Seam between the Acadia and Nova Scotia
eries similar to that between the Acadia and Drummond collieries, and
ie specimens analyzed by Prof. Silliman were fair representative sam-
of the whole seam, this should be, theoretically, a good gas-coal.

COAL OF THE MONTREAL AND PICTOU SEAM.

MONTREAL AND PICTOU COLLIERY.

'he works of this company having been abandoned before my visit, and Montreal and Pictou Co's. coal.
pit being full of water, during my stay in the region I was unable
procure samples of the seam or seams met with in the workings. The
owing note by Prof. How is, I believe, the only reliable information at
sent attainable concerning this coal :—

" *Coal of the Montreal and Pictou Mines.* I examined several sam- How's analyses
s of the coals raised on the first opening of the seams ; the following is
abstract of my Report made to the company as respects the qualities of
coals.

" Sample No. 1, from the first bench, gave :— First bench.

Moisture	4.40
Volatile combustible matter	24.95
Fixed carbon	61.07
Ash	9.58
	100.00
Coke	70.65
Theoretical evaporative power	8.39

" This coal has considerable evaporative and heating power, and would
ve a moderate amount of gas of good illuminating quality. The appear-
ce of the coal is much in its favour ; some that I saw taken from the seam
as very clean and bright.

" Sample No. 2, from the second bench, gave :—

Second bench.

Moisture	5.47
Volatile combustible matter	19.93
Fixed carbon	68.55
Ash	6.05
	100.00
Coke	74.60
Theoretical evaporative power	9.41
Specific gravity	1.36

"This was an extremely bright and clean coal. Its very high evapo tive power makes it occupy a good position among British and Americ coals for steam purposes."*

COAL OF THE MONTREAL AND PICTOU OIL-COAL SEAM.

Montreal and Pictou oil-coal seam.

On page 106 of the Geological Report, mention is made of a small se known on the Montreal and Pictou area, which I am inclined to ident with the Stellar seam of the Acadia mines. I have been unable to p cure a good sample of the oil-coal from this seam, but a small specim taken from the out-crop on the quarry road, much weathered and by means fairly representing the seam, has been analysed by Mr. Broo with the following result:—

Analysis.

	Broome.
Volatile at 100° C., (moisture)	2.40
Volatile at 200° to 250° C	34.20
Total volatile matter	47.35
Fixed carbon	34.05
Ash, (very red and ferruginous)	18.60
	100.00

Description.

This substance is, in external character, very much like the stellari It presents the same dead-brown fracture, and shows glistening points bituminous matter, which, on being ignited, melt and drop from the fo ceps. The facility of its ignition and continuity of combustion of a sma piece, when removed from the flame in which it has been lighted, is on equalled among the oil-coals of the region, by the stellarite, and these fact together with the results of Mr. Broome's analysis, tend to confirm m identification of the seams.

COAL OF THE CULTON SEAM; CULTON ADIT.

Coal of the Culton seam.

I have been unable to obtain a specimen of the coal of this working. I character has been described to me by several who have burnt it, as th of an exceptionally good, and very highly bituminous coal.

* How, Mineralogy Nova Scotia, p. 27-8.

COALS OF THE EAST SIDE OF THE EAST RIVER.

COALS FROM MCBEAN'S EIGHT-FEET SEAM, MCBEAN'S SLOPE.

First Bench. Upper twelve inches of the seam.

The coal is a bituminous coal, with dead-black planes of deposition, show- little mineral charcoal. It is inclined to be a little shaly, but the cleat cross-fracture surfaces are brilliant. The following analysis is the ult of an examination of two specimens from quite near the out-crop :— Coals of McBean's 8-feet seam. First bench.

	Hartley. I.	Hartley. II.
Hygroscopic water	1.57	2.67
Volatile combustible matter	29.29	28.65
Fixed carbon	52.36	49.66
Ash (white)	16.76	19.42
	100.00	100.00
Coke	69.14	65.08

Analyses.

hese samples analysed were taken by myself from the seam, and were rently an average of the bench. The coal burns well, forming a very laming fire, and the ash, though bulky, is perfectly white, free from and would fall at once through grate bars. No sulphur was discov- by ordinary tests. The coke does not hold together well.

econd bench, (about twelve inches below first bench.)

appearance this coal is similar to the last, except that there appears no mineral charcoal visible on the planes of deposition, and the lus- f the cleat planes is very brilliant. The specimens analysed are from lope about 40 feet from the crop, and show scales of calc-spar in the s. Analysis I is from the top of the bench. Six inches below is a th parting, and analysis II, is from coal just below the parting. Second bench.

	Hartley. I. Top of Bench.	Hartley. II. Bottom.
Hygroscopic water	2.67	1.94
Volatile combustible matter	27.20	23.95
Fixed carbon	54.86	57.17
Ash (white)	15.27	16.94
	100.00	100.00
Coke	70.13	74.11

Analyses.

ttom bench (lower six feet of seam).

is coal shows but little tendency to break with the lamination, and neral charcoal is seen, even the deposition-planes being brilliant. ure conchoidal. It burns freely, giving a very hot fire ; the ash is ight, sandy and not inclined to clinker ; it would fall at once through ate bars of a furnace. No sulphur was found by ordinary tests. Bottom bench.

The samples analysed were taken about 50 feet from the crop. coke, if the coal is properly carbonized, is very fair. The following a ses of averages have been made :—

Analyses.

	Hartley. I.	Hartley. II.
Hygroscopic water	2.22	3.00
Volatile combustible matter	30.23	29.61
Fixed carbon	59.70	59.51
Ash (white)	7.85	7.88
	100.00	100.00
Coke	67.55	67.39

This coal should make an good gas-coal, as the percentage of tile matters is quite large in comparison with many of the coals of th trict. I am not aware that any practical trial has ever been made as a gas-producer. From its rapidity of combustion and freedom sulphur, it would also appear to be well fitted for ordinary steam pur

COAL OF THE GEORGE MACKAY SEAM, MARSH COLLIERY.

George Mackay seam.

This coal is coarsely laminated; the deposition-planes have a ver lustre, and show a great many patches of mineral charcoal. The planes are inclined <83° to the bedding; the joints show many sca calc-spar, which is not adherent to the coal, but crumbles under the f

Coal of Marsh Colliery.

The following analyses of two specimens from the Marsh pit, 24 deep, and striking the coal seam about 1,000 feet from the crop, this coal to be of very good quality, notwithstanding its rather appearance :—

Analyses.

	Hartley. I.	Hartley. II.
Hygroscopic water	none.	none.
Volatile combustible matter	29.72	29.98
Fixed carbon	62.28	62.15
Ash, (buff coloured)	8.00	7.87
	100.00	100.00
Coke	70.28	70.02

The percentage of ash is decidedly low. A trace of sulphur was but being, probably, under one-half of one per cent., was not esti As the specimens examined do not coke particularly well, it would that this coal is best fitted for a steam-coal.

COALS OF LAWSON'S SEAM; LAWSON'S SLOPE.

Lawson's seam.

The specimens examined were taken from the slope sunk by Mr. Lawson, M.E., for the Montreal and New Glasgow Coal Company,

bank of Potters' Brook, near the Merigomish telegraph road. At this king, the seam, as measured by me, was divided into the following ches:—

Section at Lawson's slope.

	Ft.	In.
Cannel coal, (varies in thickness,) about	0	6
Mineral-charcoal bench	0	2
Good coal	2	7
Coarse (but good) coal	0	5
	3	8

Cannel-coal Bench.

annel-coal bench.—This coal appears to be a true cannel, being of a ogeneous texture, and dead grayish-black colour. The fracture is hoidal, lustrous, streak brownish-black. In some places this cannel mes shaly, breaking roughly with the deposition-planes, which are a black and in many cases tinged dark red with iron rust from iron tes, which occurs in small lenticular masses; cleat planes vertical to bedding. One specimen shows a coprolite. A picked sample of this h gave :—

Analysis.

	HARTLEY.
Hygroscopic water	.47
Volatile combustible matter	41.18
Fixed carbon	48.19
Ash, (reddish or purple)	10.16
	100.00

his specimen gave a very large quantity of very highly carburetted but the coke is not of the best quality.

Mineral charcoal bench.

ineral-charcoal bench. Interlaminations of mineral charcoal and ht bituminous coal form the material of this bench. The specimens nined show small veins of calc-spar in the joints of the coal, which are any cases inclined at an angle of only 45° with the bedding. This bench s a great deal of iron pyrites, coating the patches of mineral charcoal a bright film, and giving them the appearance of having been gilded. analysed.

Good-coal bench.

ood-coal bench. Colour of coal dull black, very compact and heavy, occasional patches of mineral charcoal. It shows but little tendency eak with the planes of deposition, and has generally a sub-conchoidal sometimes a ragged fracture. The specimen examined contains a t deal of sulphur, in the form of iron pyrites, which if present in the of the coal, would altogether unfit it for steam or domestic uses. It s, however, with a very bright and hot fire, though the ash is very y, and sometimes chokes the fire if not properly cleaned.

he following analysis of this coal is given in a report by Dr. J. W. son, to the owners of the East River coal area:—

Dawson's analysis.

	DAWSON
Volatile matter, (moisture included)	25.4
Fixed carbon	50.0
Ash	24.6
	100.0

The ash from this coal is generally red or reddish-gray.

Coarse-coal bench.

Coarse-coal bench. The coal of this bench is very coarse in tex having two sets of cleavage joints, very distinctly marked, which, wit planes of deposition divide it up into small cubical blocks, giving appearance known technically as *dicey.* The surfaces of the coal the joints are generally rendered very dull in colour from the preser fire-clay from the underclay of the seam, which softens when exposed t atmosphere or percolating water, and is forced by the superincur pressure up into the open joints of the coal, presenting the phenome a *creep*, on a very small scale. This coal, were it not for its tenden crumble (from its open texture), would be an especially good coal, as be judged from its extreme lightness. The following analysis of a spec from this bench presents a most remarkable contrast in content of as spite of the fireclay in its joints) to the overlying bench :—

Analysis.

	HARTLEY
Hygroscopic water	1.82
Volatile combustible matter	28.47
Fixed carbon	63.93
Ash, (buff-coloured)	5.78
	100.00

A determination of ash in another sample, gave 6.07 per cent.

COAL FROM THE "OLD FRAZER MINE." *

Foster seam.

I have not examined the coal from this seam, but on the author Dr. Dawson, it is stated to be "a good coal of uniform quality." † distinguishes the seam in his Report, as the *Foster seam*, and give following analysis of the coal:—

Dawson's analysis.

	DAWSON
Volatile matter, (including water)	29.0
Fixed carbon	53.4
Ash, (reddish gray)	17.6
	100.0

* Report of Sir William E. Logan, p. 44.

† Report of Dr. J. W. Dawson to East River Coal Company.

COAL OF THE RICHARDSON SEAM, (PIT AT THE CROWN POTTERY.)

n appearance this coal is rather coarsely laminated, and its only tend-y to break is roughly with the deposition-planes. In colour it is jet-k, the only perfectly black coal examined, and in the specimens lysed, all the surfaces, whether of deposition-planes or fracture, were liant, showing no trace of dead-black mineral charcoal, a very unusual g with coals of this district. It is the most highly bituminous *true* coal ne district (so far as I am aware,) and I should judge from the analysis it would be an admirable gas coal, for which purpose it should be ed. It gives a very good coke, and the ash is very light, perfectly e, and silicious or sandy, and therefore will not be inclined to clinker. the whole this seems to be a coal of remarkable purity, if fairly esented by the specimens I have seen. The pit not being open during isit, samples were taken from a small heap of coal lying beside it, h however, had been for some time exposed to the weather. The fol-ng is an analysis of an average of these samples:— Richardson coal.

	HARTLEY.
Hygroscopic matter	.76
Volatile combustible matter	38.84
Fixed carbon	55.81
Ash, (white)	5.09
	100.00
Coke	60.90

Analysis.

sulphur was detected by ordinary tests. The content of ash, it e observed, is lower than in any other coal of the district of which an sis is given in this Report, with a single exception. Should the rdson seam be proven over any considerable area, it would seem ble that, although quite small, it might be profitably worked with rices of coal, especially if taken out in connection with a valuable bed clay, which underlies it a few feet, and which has already been d to a small extent for pottery and fire-brick manufacture, by the Brick and Pottery Company of New Glasgow.

UPPER OIL-COAL OR OIL-SHALE SEAM.

substance included in this seam varies very greatly in external ter between the two extreme points where it is known, at Halibur-pit on the Marsh Brook, and at Andrew Patrick's old slope on lan's Brook, a short distance below the Fulling-mill bridge. Oil-shale seam.

OIL-COAL FROM ANDREW PATRICK'S MINE.

Andrew Patrick's oil-coal.

The oil-coal from this mine occurs both shaly and *curly*, the latte cription appearing to be the most valuable. That portion having the texture much resembles the stellarite in appearance, but is much he and has a lighter brown colour. It weathers a very dark gray. Th lowing analysis has been made by Mr. Broome of some large sa selected by Sir William E. Logan in 1868 :—

	BROOME.
Volatile below 200° Centigrade, water and some oil	.67
Volatile at 200° C., (oil)	14.73
Total volatile matter	33.91
Fixed carbon	6.11
Ash (grayish-brown)	59.88
	100.00
Coke	66.09
Specific gravity	1.747

This oil-coal has been used in the manufacture of burning-oil, I b but I am not aware of the quantity of oil produced per ton.

OIL-COAL OR SHALE, FROM THE MARSH BROOK.

Oil-coal from the Marsh Brook.

This substance appears to be an argillaceous shale, of a g black colour, giving a brownish streak ; the bedding is not well m except on surfaces of fracture, where the lamination can be trac numerous small brilliant points, apparently bituminous, which are in between the laminæ. A thin section of this oil-shale under the micr presents the appearance of a dark brown or black ground, nearly o with numerous spots of yellow, which are translucent ; the black g being the shale, and the yellow points the included hydrocarbon matter. The following analyses of this substance have been ma first being of a specimen procured in 1868, by Sir William E. from the pit on the Marsh Brook known as Haliburton's pit:—

Analysis.

	HARTL
Hygroscopic water	1.0
Volatile combustible matter	27.4
Fixed carbon,	9.2
Ash, (grayish-brown, shaly)	62.2
	100.0
Specific gravity	1.6

Since the above analysis was made, I have procured other specimens m the same pit, one of which was analysed by Mr. Broome, with this ult :—

Analyses.

	BROOME.
Volatile at 100° C, (water and some oil)	.596
Volatile at 200° C	11.250
No. 1, Rapid coking.	
Total volatile matter	40.600
Fixed carbon	.400
Ash, (grayish-brown)	59.000
	100.000
No. 2, Slow coking.	
Total volatile matter	35.540
Fixed carbon	5.260
Ash	59.200
	100.000

he above results show that this shale is composed almost entirely of tile matter and ash, the amount of fixed carbon being dependent on rapidity of carbonization. This shale has been tested for oil, but the lts I have not heard. Theoretically, it should be a valuable oil-shale.

II.

PRACTICAL TRIALS OF PICTOU COALS.

Value of practical results.

In the first portion of Section I, I have already drawn attent the great importance of practical trials of coals as steam and ga ducers, and for other purposes of the industrial arts; and I have in tally mentioned that several series of experiments on coals, with a v ascertaining their evaporative value, had been carried out, so far coals of Great Britain and the United States were concerned, b British and American governments, respectively. My attention was cially called to this matter during my examination of the Pictou district endeavouring to collect materials for a report on the coals of that re by the almost total ignorance prevailing, of what work the coals practically perform, or for what work they were best fitted. With one e tion no figures could be obtained which would prove any of the co be valuable as steam-coals, that exception being the values furnishe a trial incidentally made (for comparison) by the American Govern during the series of trials of United States coals;—of the Albion- coal shipped in 1843 or 1844, when the upper twelve feet of the Main was the only coal worked. Although fully satisfied, from observin success with which the coals were burnt, in the region, under static locomotive, and marine boilers, that many of the coals were well for steam-producers, I was, at the same time, aware that a report m giving my own opinion, would not have the value that would attach report of systematic trials, of which the results could be stat figures. Being aware that no experiments could be undertaken s to those of the Admiralty and American navy trials, it became nece to devise some plan by means of which the use of the necessary appa could be obtained without great expense. The proper method have been, of course, the use of the same boiler for all coals, which should be fitted with proper grates, flues, etc., for burning each c the most economical manner. As this would have entailed the er of such an apparatus at the public expense, it appeared out of the que and the only plan seemed to be to make such trials on locomotives steamers as could be carried out with a small expenditure, throug liberality of the coal-owners, or other parties interested in knowin true value of the coals.

Plan adopted for steam-trials.

Having obtained the consent of Sir William E. Logan, then Direc this Survey, I broached the subject to the agents of the several coll which were in active operation, about the middle of the month of Oc

ıst, and, through their kindness, several trials were at once arranged for. Coal trials. hrough Mr. Jesse Hoyt, Manager of the Acadia Coal Company, I was ermitted to make a trial of the Acadia steam-coal on the Provincial · Nova Scotia) Railway, by Mr. Lewis Carvell, General Superintendent ' the railways of the provinces of Nova Scotia and New Brunswick, ıd many facilities were granted me by him, and all the other officials of e Railway Department.* At Mr. Carvell's request, another trial was ade, shortly after, on the same railway, with wood, for a comparison of e two fuels.

Through Mr. Hoyt, and Mr. Hales, Manager of the Prince Edward land Steam Navigation Company, a second trial of the Acadia coal ıs then made, on the steamer " St. Lawrence," of the P. E. I. Navigation ompany's line. As before, I was granted every facility by all the officers the line, and especially by Mr. Hales.

A third trial was that made with wood on the Provincial Railway, as Wood trial. ove referred to. This was undertaken at Mr. Carvell's request, in der to institute a comparison between wood and coal by practical periment. By reference to that portion of this section headed ' Comrison of Coal and Wood,' it will be seen that the results were greatly favour of coal.

Coal from the Acadia West colliery had been used on the Windsor anch of this railway, for some months, but, so far as I am aware, no train d been run over the main line from Pictou to Halifax with a coal-burning gine previous to my experimental train—the fuel hitherto used having en wood, furnished the railway by contract. I believe that the final sult of my comparative experiments will be the complete abandonment wood as a fuel on this railway, (so soon as the engines can be fitted for rning coal,) with very considerable saving in expense and time.†

The fourth trial was made on December 3rd., through the kindness of r. Dunn, Manager of the Intercolonial Coal Mining Company, on that mpany's railway, with a Scotch coal-burning engine, and a loaded coalın. In this experiment I was materially aided by Mr. William awford, C.E., the Company's Chief Engineer, who accompanied me on the gine, and noted the times of passing many points, by means of which a ry complete record of the performance of the engine was obtained. previous trial had been attempted on this railway, but it was stopped stormy weather (rain and sleet), which prevented a proper adhesion the driving-wheels to the rails. I ammuch indebted to Messrs. Dunn l Crawford for the facilities given me in these trials.

I would especially acknowledge my obligations, for courtesies and information eived, to Mr. Alex. MacNab, C. E., Chief Engineer of the Nova Scotia Railway.

A detailed Report on these experiments will be made to Mr. Carvell, during the sent season, by permission of the Director of this Survey.

Trials postponed.

A number of similar trials were planned for the middle of the mo December. Mr. Hudson, General Manager of the General Mining ciation, placed the railway of that company, and a fine 26-ton E coal-burning engine at my disposal, for experiments on coals of the and Deep seams. Trips on the Association's steamer "Dragon a trial of Dalhousie-pit and Cage-pit coals, were arranged for, but con stormy weather prevented these trials until it became necessary to return to Montreal, when it was decided to postpone them unt coming season, during which it is intended to complete the investig

In all of these experiments the greatest care was taken to burn the as economically as possible, and in notes of the performance c engines and furnaces, the system of minute-blanks, first institu believe by Messrs. Bunning and Richardson, in their experimen Devonport, and on the steamer "Weardale,") on North Country coal adopted. As my experiments are not yet complete, it is not de advisable to publish these notes in full, at present, and therefore, i present Report, only an abstract of the principal facts of interest obt is given, the detail being reserved for future reports, when the ser trials for this region shall be completed.

To my own experiments on Acadia and Intercolonial coals, are a an abstract of the experiments on Albion-Mines coal, by Prof. W Johnson, in 1843-1844, for the American Government; and a vari statements concerning the value of the different coals of this regio gas-making and other purposes, which need not be here named in de

TRIAL No. 1, ACADIA STEAM COAL.

Railway trial of Acadia coal.

Date:—Nov. 3rd, 1869. On Nova Scotia Railway.
Trip:—From Pictou Landing to Richmond (Halifax).
Distance:—112 miles.

DETAILS OF EXPERIMENTAL TRAIN.

Locomotive used:—No. 7, N. S. Railway.

Description.—Coal-burner altered from wood-burner. Built 1857, by Neil Co., Glasgow. Tender-engine, four driving-wheels, 5′ in diameter; cyli (2) $16\frac{1}{8}''$ diameter × 21″ stroke. Has a rocking grate, (six bars 2′ 9″ lo $7\frac{1}{16}''$ wide,) hung with $\frac{1}{8}''$ clearance, making grate 3′ 8″ wide, and giving 10 square feet fire-surface. In each bar there are sixteen openings $\frac{11}{16}''$ × which, with openings between bars, and at sides and ends, give abo square feet air-passage in grate. Grate is rocked by movable bar.

Experimental train.

Weight Train. P

Engine.—The total weight of Engine No. 7, without tender is...... 6
(Of this 35,650 lbs. is effective weight on drivers.)
Weight of tender, with water, without coal........................ 4
1 supply platform-car, (coal); weight at start..................... 3
5 box-cars, each carrying 100 barrels of flour..................... 18

6 coal (platform) cars, (loaded)	205,090
1 first-class passenger-car	28,260
Officers and passengers	1,820
Total weight of train at start	558,910
Or about	249 tons, 10 cwt.

The length of this train, from front of leading-wheels of engine, (forward ruck,) to rear wheel of last car, was 457 feet.

This train started from Pictou Landing at 10h. 23m. A.M., and with ngthy stoppages to pass up-trains, at several stations, arrived at Richond station at 9.17 P.M. Trip.

The account of actual time and stoppages is as follows:—

	H. M.
Time of train on road	10.54
Length of stoppages	4.44½
Actual running time	6.09½

The character of the line run over, may be briefly described as being fficult for the first 39 miles, with up-grades as great as 67.58 feet to the ile; easy, from 39 miles to 52 miles; and with grades ranging from level a rise of 50 feet to the mile, for the rest of the distance. The resistance ncountered on these grades was materially increased by numerous curves, tween Pictou Landing and Riversdale (39 miles), the sharpest of which as 955 feet radius; and also by several sharp curves on the line between Vindsor Junction and Richmond, the sharpest of which has a radius of ly 792 feet. Line passed over.

During the trip, the coal had several severe tests as a steam-producer, for instance between mile-posts 17 and 29, where the grades range from .90 to 67.58 feet per mile. These grades were ascended at an average eed of 10 to 13 miles per hour, and on the steepest, (Summit grade,) 67 et per mile, with a curve of about 1000 feet radius, the engine kept up eam well, losing only 4½ lbs. in 6 minutes, with both pumps on; * and king 59 revolutions per minute at the top of the grade.

The grate was shaken but three times; at Glengarry (24 miles), Brookld (60 miles), and Elmsdale (83 miles). No inconvenience was felt m ash, although the engine had a tight ash-pan, until Elmsdale was ched, when the throats of the dampers, forward and back, were found be slightly choked with ash, and were cleaned, about 20 lbs. of ash being noved. The smoke-box was also opened, and about a bushel of cinders en therefrom, which had covered a few of the lower tubes. With an

Pumps of Engine No. 7, are two 2″ plungers; 21″ stroke.

ordinary train, it is probable that neither of these cleanings woul needed, but this experimental train was, I believe, the heaviest eve over the road.

STATEMENT OF COAL BURNT.

Coal consumed.

The following is a statement of the amount of coal consumed on trip:—

	Pounds.
Weight of supply-car at Pictou Landing..............	35,380
" " Richmond	29,530
Coal put on tender................................	5,850
Deduct coal left on tender	214
	5,636

Or in round numbers 2 tons, 10 cwt. = 50.3 lbs. per train-mile, or 3.87 lbs. per car-mile.

Ash and clinker.

The amount of ash and clinker from this coal was 552 lbs., or abou per cent. The ash was gray, with a reddish tint, the clinker brittle, w flesh tint, in some places inclining to reddish. No clinker was obs adherent to the bars, and no pieces of clinker of a size exceeding thr four pounds.

Water evaporated.

The water evaporated was estimated by carefully gauging the ta the tender at each water-station, and calculating the weight of the nu of cubic feet passed into the boiler, as given by the gauge-marks. Alth liable to errors, it is probable, from the number of gaugings, that errors will nearly balance one another, and that the general totals w correct. The following is the calculated weight of water evap between stations:—

		Pounds.
Between Pictou Landing and Glengarry.	24 miles....	10,542
" Glengarry and Riversdale.....	15 "	4,869
" Riversdale and Pollybog......	26 "	5,873
" Pollybog and Windsor Junction	35 "	10,291
" Junction and Richmond......	12 "	3,137
Total, between Pictou and Richmond..		34,712

Result.

This is equal to 6.159 pounds of water evaporated, to one pound c burnt. The average temperature of the feed-water, for the trip about 40° Fahrenheit, and the evaporative power of the coal for from this temperature being equal to 6.159 lbs., its evaporative in pounds of water from 212° F., would equal 7.24 lbs., to one of coa

* This result is obtained without taking pressures of steam into consideration, would involve a lengthy discussion of varying pressures at different points on the It is only an approximation.

This result, which I consider remarkably good, was obtained, not from picked sample of the coal, but from a fair average sample of the product f the colliery. The supply-car was taken as an average of a train of n platform-cars of coal raised at the colliery on November 2nd, the day efore the trial; the weight of coal on these cars being somewhat above 100 ns.

TRIAL NO. 2, ACADIA STEAM COAL.

Date :—November 5th, 1869.—On Prince Edward Island Steam Navi-ation Company's steamer "St. Lawrence." Steamer-trial; Acadia coal.

Trip :—From Pictou Landing, Nova Scotia, to Charlottetown, Prince dward Island.

Distance :—About 59 miles.

DETAILS OF STEAMER "ST. LAWRENCE."

This vessel is a side-wheel coast steamer, of the American pattern, with loon and promenade decks above the hull. Her tonnage, according to er papers, is as follows :— Steamer "St. Lawrence."

	Tons.
Tonnage under deck	382.61
" for propelling power	170.53
" houses, over deck	463.02
Gross tonnage	845.63

Her dimensions are :—

	Feet.
Length, total	201.5
Main breadth, (amidships)	30.2
Depth from deck	9.9

Her engine is a vertical-cylinder beam-engine of the American pattern. he details of engine, boiler, etc., are as follows :—

Engine.—Cylinder 44″ by 11′ stroke with Steven's cut-off; cutting off at $5\frac{1}{2}$ feet (half roke). (250 Nominal H. P.) Machinery.

Boiler —Compound boiler, (return flues and tubes). Breadth across three fires 13′ 6″; ngth at furnace 8′ 6″; cylindrical shell, 15′ 6″ long, and 11′ 6″ in diameter. The tails of the flues are :—Outside furnaces, three flues, respectively, 10,″ 17″, and 19″ ameter; centre furnace, four 14″ flues. Above these flues are 96 tubes, 17 feet long id 5″ diameter.

Steam was up at the commencement of the trial, but before putting on ny weighed coal the furnaces were cleaned of coal and ash, about 300 os. of fire being left for the start. At 11.30 A.M. 1200 lbs. of coal were ut on to the fires, making in all 1500 lbs. put on before starting. The art at full speed was made at 12 h. 35 m. P.M., and the engines were then

run at regular speed during the entire trip to Charlottetown. The acco panying table shows all the detail of firing and performance of the engin and gives almost all the information of value obtained during the trial. shows the regularity with which the engines were run, and pressure steam kept up with but little trouble on the part of the stoker. The reas that this table is given, is that in several published reports relating Provincial coals, it has been stated that in using these coals great amount of trouble is given to the fireman, through the coal clink ing and adhering to the bars, requiring perpetual raking and slicing to bre up the fire in order to keep up a good draught. These statements are co pletely refuted by the notes given in the table, which shows that during t three hours commencing with 1, 2, and 3 o'clock, while the steamer w running regularly, no breaking up of the fire was needed; that the fires in a three furnaces were raked only four times, and that so far from th draught being obstructed, the fire-doors were frequently open for a nu ber of minutes each hour, to admit air above the fires. The table is to regarded simply as a transcript of the notes; and as no similar trials ha yet been made with which the results might be compared, any farth discussion of these notes will be of no practical value.

Behaviour of coal under marine boilers.

Coal consumed.

The weight of coal consumed upon this trial was as follows:—

	Pounds.
Left on fires at start, about	300
Fires banked before starting, with	1,200
Actually consumed during trip	6,441
Total	7,941

of which 1326 lbs., or 16.69 per cent., was ash, clinker, and unbur coal; the unburnt coal would probably equal about 100 lbs. No piece clinker was observed of a size over four inches cube, and none adhered to th grate bars. The bars in the furnaces of the " St. Lawrence " had bee in use for eight months, at the time of my trial, during which tin Acadia coal has been burnt, and they showed no sign of fire-mark, an were every way in as good condition as when put in. I was informed Mr. Turner, Chief Engineer of the P. E. I. Steam Navigation Compan that the bars in the " Princess of Wales," of the same line with the St. La rence, and also burning Acadia coal, had been in for some two seasons, (t running season being about eight months,) and that they were still in goo condition. The importance of these facts will be appreciated by a engineers.

Grate

The officers of the steamer St. Lawrence, are: — Master, E. Evan Chief Engineer, Jas. Turner; first assistant, Arch. Livingston; to all whom I am indebted for their courtesies during my experiment. I wa

No. 2. ACADIA STEAM COAL.

TABLE SHOWING FIRING, AND PERFORMANCE OF THE ENGINES.

sisted by Mr. Thos. Lawther, of the Albion Mines, who took notes in the e-room, of the firing and weight of coal used.

Beside the notes given in the table, minute-notes were taken, during veral hours, of the smoke emitted from the funnel of the steamer, from iich the smoke-equivalent of the Acadia coal, as burnt in the furnaces of e St. Lawrence, appears to be about 120 ; showing that the coal is not irnt by any means as economically as is possible.* Smoke.

It was first my intention to include the notes of the smoke, or *smoke-arks*, in the table of firings, but as the notes were taken by a person th but little experience in this matter, I reserve them for a future report, corroborated by subsequent experiments.

TRIAL No. 3, WOOD.

(FOR COMPARISON WITH ACADIA STEAM COAL.)

Railway trial of wood.

Date :—Nov. 10th, 1869. On Nova Scotia Railway.
Trip :—From Pictou Landing to Richmond (Halifax).
Distance :—112 miles.

DETAILS OF EXPERIMENTAL TRAIN.

Locomotive used :—No. 19, N. S. Railway.
Description :—Wood burner by Neilson & Co., Glasgow. This engine is of the me pattern and dimensions as No. 7, and before the alterations in furnace and draught rangements of No. 7, the two engines were precisely similar. This engine was not eighed, but the weight may be safely taken as the same as that of No. 7.

Experimental train.

		Pounds.
Weight of Train.—	Weight of engine without tender	66,130
	Weight of tender with water, (without fuel)	40,340
	5 box-cars, each carrying 100 barrels of flour	181,040
	7 coal (platform) cars, (loaded)	229,670
	1 first-class passenger car (same as No. 1 Trial)	28,260
	Officers and passengers	1,820
	Total weight of train, not including wood on tender, which amounted to 1½ cords, or about 3 tons, 3 cwt., at start	547,260

	Or about	244 tons,	7 cwt.
"	Add fuel, at start	3 "	3 "
"	Total weight with fuel about	247 "	10 "

*For discussions of the subject of the economical use of bituminous coals as steam-producers, see the Reports of Messrs. Richardson and Bunning, " On the experiments at eyham, on the use of mixed Hartley (Newcastle) and Welsh coals in Marine boilers," rans. North of England Institute of Mining Engineers, Vol. XIV ; — the " Report of a ommittee on the Smoke Question," Ibid., Vol. XVIII, p. 37 et seq. ; and Mr. Bunning's eport on Experiments on Hartley coal, on the steamer Weardale, Ibid. Vol. XVIII, . 105. These experiments will be again referred to, and some notes on this subject iven, in the latter portion of this Section of this Report.

Or only about two tons less than the train in Trial No. 1. The len of train was, as before, 457 feet, the same number of cars of e class being used.

Trip.

This train started from Pictou Landing, at 8 h. 34 m. A.M., and a many stoppages, as before, to pass up-trains, and to allow regular d trains to pass, reached Richmond station at 9. h. 18½ m., P.M.

The account of actual time and stoppages is as follows :—

	H. M.
Time of train on road	12. 44½
Length of stoppages	5. 55¾
Actual running time	6. 48½

The character of the line has already been described, under Trial No and the conditions of weather, track, etc., under which the two trials w made were as nearly as possible similar. Steam was kept up well by engine, but with much greater labour of the fireman than during the p vious trial. It is difficult to make a proper comparison between the experiments in this particular, without a table showing the vary pressures on the different grades throughout the entire length of the li Such a tabulation has been made in manuscript, but will not be here giv as it would necessarily extend the size of this Report. It shows no imp ant difference between coal and wood. It has already been noted that the Summit grade (67.58 feet to the mile, with a curve of about 1000 f radius), the engine in the coal-trial made 59 revolutions per minute, v both pumps on. Under precisely similar conditions, the wood-engine, w a train of about two tons less weight, made 47 revolutions. Thus, in severest test during the experiments, the coal gave the best result.

With wood, as may be expected, no attention to ash or cinder necessary.

STATEMENT OF WOOD BURNT.

Wood consumed.

The following is a statement of the wood taken on to the tender dur the trip :—

Wood taken on at Pictou Landing		1½	Cords.
" " " " Glengarry	24 miles	¾	"
" " " " Riversdale	38 "	¾	"
" " " " Pollybog	64 "	½	"
" " " " Windsor Junction	99 "	½	"
Total taken on to tender during trip		4	Cords.
Remaining on tender at Richmond		¼	"
Total wood consumed on trip		3¾	Cords.

This wood (dry), weighs about 2 tons 1 cwt. per cord ; the total quantity nsumed would thus amount to about 17.210 lbs., equalling 7 tons 14 't., nearly. This is equal to 153.66 lbs., per train-mile, or 11.88 s. per car-mile.

The weight of water evaporated was estimated as in the previous railway trial. The calculated amounts used between stations are :— Water evaporated.

			Pounds.
Between Pictou Landing and New Glasgow,	8	miles.	2,761
New Glasgow and Glengarry	16	"	7,831
Glengarry and Riversdale	15	"	5,175
Riversdale and Pollybog	26	"	7,530
Pollybog and Elmsdale	18	"	5,330
Elmsdale and Windsor Junction	17	"	6,024
Junction and Richmond	12	"	2,886
Total between Pictou and Richmond			37,537

This is equal to 2.181 pounds water evaporated for one pound of wood rnt, the temperature of the feed-water being, as before, about 40° Fahnheit. The quality of the wood used on this trial, was, in my opinion, nsiderably better than the average supplied to the railway ; at least in a imber of trips between Pictou and Halifax, I have never seen as good iality used ; it was principally hard-wood, birch, etc. Results.

COMPARISON OF COAL AND WOOD.

(DEDUCED FROM TRIALS OF ACADIA COAL AND WOOD, ON THE N. S. RAILWAY.)

In regard to length of trip, condition of track, and weight of train, the mparative trials may be said to have been made under nearly similar rcumstances. The weight of train in the wood-trial was two tons less the start than the train in the coal-trial, but the amount of wood added iring the wood-trial at different points, and carried varying distances, pro-bly equalled two tons carried the entire distance. The length of ppages during the wood-trial was 1h. 1½m. longer than in the coal experent, which would result, though to only a small extent, in favour of coal. ll things considered, however, the conditions in each were practically e same, and it now only remains to compare the results, in the most iportant particulars of time, labour of men, first cost and expense in e of the two fuels. Comparison coal and wood.

Time.—It has been remarked on the preceding page that no important fference has been shown by the notes taken of the steam-gauge during the o trials. That there must be some difference in favour of coal, in capaty for keeping steam, will be seen by a comparison of actual running time, hich stands as follows :— Time.

	H.	M.
Actual running time, wood trial....................	6	48½
" " coal trial......................	6	09½
Difference in favour of coal..........................	0	39

A saving of time might be effected if coal were used, from the fact t enough coal might be put on to the tender at the start from either termi of the railway, for the entire trip. This could not be done in using wo for several reasons:—first, because the capacity of the tender would be sufficiently great; and second, even if the tender were of suffici

Time lost in wooding-up.

capacity, the great weight carried, (7 or 8 tons of wood, to say nothi of the greatly increased weight of tender,) would be a material objecti

In the first of the experiments under consideration, the greater par the coal consumed was put on the tender at Pictou Landing, a small p tion being added from the supply-car during the last 25 miles. As entire quantity *might* have been added, without inconvenience, at the sta we may assume that no time was lost in coaling.

During the second trial, the record of time consumed in *wooding-* stands as follows:—

At Glengarry.........3	men employed in wooding		9	minutes.
" Riverdale..........3	"	"	7	"
" Pollybog...........2	"	"	6	"
" Windsor Junction..3	"	"	5	"
Total time employed in wooding................			27	minutes.

As it was generally known along the line that this train was an exp mental one, it is but reasonable to suppose that, at least, the usual celer in wooding was attained. The account includes only the actual ti employed in throwing the wood on to the tender. Probably several minu might be added for time consumed in getting the train in position at wooding-station, starting, etc. If we suppose this extra time to amou to three minutes, we then have one half hour of time lost in taking in wo between Pictou and Halifax.

Labour.

Labour of men.—It will be evident from the last paragraph that a c siderable amount of labour would be saved at the various stations were the fuel for a trip carried from each terminus. This, however, prope comes under the head of expenses, and the only point to be here consid ed is the difference in labour of the fireman, which is very considera as will be seen by a comparison of the two fuels burnt:—coal, 5,636 lb wood, about 17,210 lbs.; divided into, respectively, 76 and 136 firing

Comparative expense.

Comparative expense.—Not being connected with this railway, have no means of estimating, except in the rudest manner, the comparat

ense in the use of the two fuels. An approximate idea can be gained a moment's consideration of the general management required to supply ns at the termini, and at various points along the road.

Vood.—After being cut, the wood is generally corded at or near some at on the main line, from whence it is taken on extra wood-trains to the erent wooding-stations, to be used as need be. This not only requires ny extra hands, but extra trains, with consequent wear and tear of ing-stock and permanent way.

Coal.—With coal, but two coaling-stations would be required; at Pictou Richmond (Halifax). The coal could be put into coal-cars at the mines, transportation to the two termini, or, should a third station be required, to ro also. At these stations a system of shutes could be arranged, by means which the coal could be put into the tender very quickly, and without handling. I shall not attempt to estimate the cost of running the line, for general information it may be stated that the cost of coal, delivered Coal Mines station, is about \$2.25 per ton, (or, say \$2.50 at Pictou ding, and \$3.00, without profit in carriage, at Halifax;) while the con-t price of wood is, I believe, \$3.50 per cord, delivered at the wooding ions. During about eight months in the year two regular passenger freight trains are run each way per day, on this railway, between Pictou Halifax, and two each way between Truro and Halifax (61 miles); to say hing of the extra and coal trains. During the winter months, only one ough-train is run, each way, per day.

TRIAL NO. 4; DRUMMOND COAL.

This trial was made on December 2nd, 1869; a previous trial, in latter part of the month of November, having been abandoned on count of bad weather. The length of the Intercolonial Coal Mining npany's railway (about 6¾ miles) not being sufficient for a proper l with a single trip; three round trips (from the colliery to the Drum-nd wharf at Granton, and back—13½ miles) were made with a loaded l train. During these trials the usual careful notes were taken of the formance of the engine, and the line being staked out in miles and half-es, the time of passing the stakes, as well as a number of other nts on the road, were also taken, to a second, by Mr. William Crawford, E., Chief Engineer of the Intercolonial Company, who kindly accom-ied me, and to whom I would express my obligations for the interest has taken in my experiments, and the valuable aid he has afforded me. Drummond coal trial.

The notes of this trial furnish a complete record of the performance of engine upon each grade, and when time permits they will be given to public, with a proper discussion of the facts elicited.

For the purpose of the present Report, however, it will be sufficient to

give the general results, and the trial will be divided into two experimen the first, (experiment A), from an improper arrangement of the ash- and grate-bars, not having been as successful as the second (experim B). The same train was used in both.

Intercolonial Coal Company's railway.

Description of line.—The down-trip from the colliery to Granton comparatively easy, as it included only about one and a-half miles of grade, ranging from 44 feet to 53½ feet per mile. The average gr on the return-trip was about 50 feet up, per mile, for the first th miles; down about 45 feet per mile, for one and a-half miles, and then with grades ranging from 23½ feet to 98 feet per mile, and averag perhaps 65 feet per mile. Some of the curves were very sharp; one 600 feet radius, and one more than one-quarter of a mile long of 655 radius, besides a number ranging from 702 feet to 1,433 feet radius.

DETAILS OF TRAIN IN BOTH EXPERIMENTS.

Locomotive used :—No. 3, Intercolonial Coal Mining Company's Railway.

Description :—Coal burner by Dûbs & Co., Glasgow, Scotland—Tank-engine drivers, 5′ diameter (coupled). Cylinders (2) 14″ diameter × 22″ stroke,—with 75 cent. of steam on piston when in full gear. Firegrate area 12.12 square feet. 152 t tubes, 1¾″ outside diameter—superficial area of which is 680.48 square feet. Wheel- of engine, 11 feet.

Experimental train.

	Tons.	cwt.
Weight of Train.—Weight of engine No. 3, empty	20	0
Equipment	5	0
12 coal cars, loaded, (75 tons coal)	116	17
Officers and passengers	0	7
Total weight of train	142	4

The length of this train from tread of forward driver was 196 feet.

The coal consumed was carefully weighed on a Fairbanks scale, and water evaporated estimated as in previous trials. The two tanks of engine were rectangular, and being exactly filled each time of takin water, the estimate of water may be relied upon.

EXPERIMENT A.

First trial.

In this experiment the grate-bars in the furnace of Engine No. 3 w not properly arranged, every other grate-bar having been removed, lea about 2 inches between the bars, through which a considerable amoun unburnt coal fell, choking up the dampers of the ash-pan (which was v small), and thereby obstructing the draught. Added to this, the day so intensely cold that the steam-gauge was frozen on the up-trip, and

s could not be properly regulated. The record of distance, time, etc., s follows :—

			Distance.
Trip 1. Down to wharf at Granton	distance 6.60 miles.		
" 2. Back to upper siding at colliery	" 6.84 "		
Total distance ; round trip	13.44 miles.		
	Min.	Sec.	
Trip 1. Time on road, no stoppage	24	46	
" 2. " " " 52 m. 20 s. stoppage 18 m., actual time	34	20	Time.
Actual running time (13.44 miles)	59	06	

During experiment A, trip No. 2, the steam-gauge was frozen, and the could not be properly managed ; the 18 minutes stoppage was time t in thawing the gauge, and getting up steam with the blower, while nding.

STATEMENT OF COAL BURNT AND WATER EVAPORATED.

The amount of coal burnt, while running and during stoppage, was 658 ; the water evaporated being 3,423 lbs. This is equal to 5.202 . of water, evaporated from the temperature of the feed water, bout 35° F.), to the pound of coal consumed, or 6.15 lbs. of water aporated from 212°, to one pound of coal, not taking pressures of am into consideration. The coal was divided into 12 firings ; 3 on the wn-trip and 9 on return-trip to the colliery. The fire-door was open minutes on the down-trip and 7 minutes on the return. The engine was a down grade 18 minutes, during the down trip (and not using steam), d about 4 minutes during the return. The fire was broken up with the icking-bar, once on each trip, which was all the attention it required, save ing. The coal steamed well, except at the close of the second trip, ien the ash-pan damper became choked with ash and unburnt coal, (the gine being designed for Scotch coal, which gives very little ash.) Results.

EXPERIMENT B.

This trial was far more successful than the first, as the full set of bars re put in, leaving spaces of but $\frac{3}{4}$ of an inch between them. The h-pan was removed, and the steam-gauge properly protected. Four trips r two round trips) were made with the same train as in experiment A. ie record of distance, time, etc., is as follows :— Second trial.

Trip 3. Colliery to wharf	distance 6.65 miles.	
" 4. Wharf to upper siding at colliery	" 6.80 "	
" 5. Upper siding to points near wharf	" 6.62 "	Distance.
" 6. Wharf to upper siding at colliery	" 6.74 "	
Total distance ; four trips	26.81 miles.	

Time.

			H.	Min.	Sec.
Trip 3.	Time on road 27m. 40s., stoppage 4m. 15s., actual time	...	0	23	25
" 4.	" " " 35m. 00s., " 7m. 38s.. " "	...	0	27	22
" 5.	" " " 21m. 05s., no stoppage " "	...	0	21	05
" 6.	" " " 41m. 25s., stoppage 8m. 10s., " "	...	0	33	15
	Actual running time, (26¾ miles)	...	1	45	07

STATEMENT OF COAL BURNT AND WATER EVAPORATED.

Results.

Steam being up at the commencement of this experiment, the am of coal consumed was 1,236 lbs., during the four trips. The amour water evaporated was 8,253 lbs.; thus the result was:—6.67 lbs. of w evaporated from 35° F., by one pound of coal, equal to 7.69 lbs. evapora from 212°, without taking steam-pressures into consideration. T result not only proves the coal to be an excellent steam-coal for locomo use, but also indicates that the coal was very economically burnt by locomotive. In comparing this result with the results of railway t No. 1, of Acadia coal, the fact should be taken into consideration t the result in the Drummond coal-trial was obtained with an eng built expressly for burning this class of bituminous coals, whereas engine used in the Acadia steam-coal trial was a wood-burner, but sligh altered, and in all probability not burning the coal in the most econom manner.

The notes of the second experiment (B) give the following facts, wh are, perhaps, worthy to be included here:--During the four trips, the num of firings was 17; the fire-door was open for draught above the grate, minutes; and the engine was on an up-grade—or using steam—during minutes.

Ash of coal

The ash from the coal burnt was gray, with a faint reddish tinge. T coal clinkered somewhat, but no inconvenience was felt from that cause the clinker did not adhere to the grate bars.

Portion of seam used.

The coal used was believed to be a fair average of the 16 feet of t seam worked; being a mixture of all the benches except the *top-coal* a *coarse-coal* at the bottom of the seam.

AMERICAN NAVY TRIALS OF PICTOU COALS.

American coal-trials by Prof. Johnson.

In a very complete series of trials undertaken for the American gover ment by Professor W. R. Johnson, in 1843 and 1844, were includ experiments on two samples of Pictou coals, both from the Old Albi mines, and taken, I believe, from the upper twelve feet of the Main sea These experiments were conducted with the greatest care, and with t exception of the British experiments, made by Sir Henry T. De la Bec and Dr. Lyon Playfair, for the Lords Commissioners of the Admiralty, t

nerican trials are probably the most complete and accurate series of als of steam-coals ever made.

As the results of Professor Johnson are of great value to the consumers Pictou coals, I shall take the liberty of including an abstract of them in s Report, especially as the volume in which they are contained Report to the Navy Department of the United States on American ils applicable to Steam Navigation, etc.," by Walter R. Johnson,) has en for years out of print. Report of Prof. Johnson.

The boiler employed in these experiments was 30 feet long and 3½ feet diameter; set over a furnace, and the heated gases after passing from the through two interior return-flues, each of 10 inches interior diameter, aped either through an opening, known in the Report as the *lower mper*, into the chimney, or when this damper was closed, it ascended m the ends of the two return-flues into an exterior flue on the *left* of the ler, and passed along this once more to the rear of the boiler, crossed the l, and entered a *right hand* exterior flue, by which, through the *upper nper*, it arrived at its exit into the chimney, entering the latter at a level y 14 inches higher than when it passed by the direct exit-flue to the ver damper. The details of heating-surface, and lengths of flues versed, together with the arrangements for heating the air before passing ough the grate, are given in the following quotation from Professor nson's report. It follows the detailed description of the boiler and flues, artial abstract of which I have just given:— Apparatus employed.

" From this description, it will be observed that the air which supplies combustion, passes first into a chamber beneath the ash-pit, about 7 t long, and 3 feet 3 inches wide, along the sides of which are several nings, by which it finds its way into the two longitudinal side chambers, feet long, 6 feet high, and 9 inches wide, between the two side walls; l having arrived, by these, at the rear of the boiler, passes 25 feet eath the flue, arriving at the *centre* of the grate after a course of 60.5 t. Thence a course of 58.5 feet brings the products of combustion to aperture through the passage, by the lower damper, into the chimney; l of 62.5 feet farther, or 121 feet from the centre of the grate, to the nt where they finally quit the boiler by the exterior flue. The part of lower arch of the boiler, exposed to the action of heat, is 130 square t, and that of the two return-flues is 157 square feet; so that when the nbustion was conducted by allowing the products to make their exit ough the lower passage, or after passing twice the length of the boiler, heated surface was 287 square feet. The boiler-surface exposed in exterior flue, or second circuit, is 90.5 feet; making the entire surface, en the products traversed four times the length of the boiler, 377.5 uare feet. The grate being 5 feet long, and 3 feet 3 inches wide, when Draught arrangements. Surfaces. Grate.

at its full dimensions, its area was 16.25 square feet; and the ratio o grate surface to the heated surface, when the combustion was carrie through the lower damper, was 1 : 17.66; when through the upper dan making the circuit 121 feet long, this ratio was 1 : 23.23.

Air-plate bridge.

"When the air-plate bridge was introduced, it covered 8 inches of length of the grate, reducing its area to 14.07 square feet, and increa the ratio of heated to grate surface to $\frac{377.5}{14.07}=26.83$ to 1.

"During a few trials the grate was still farther reduced in area, by introduction at the front end, next to the fire-doors, of a plate of iro feet 3 inches long, 11¾ inches wide, and one-fourth of an inch thick.

Coking-plate.

is termed the "*coking-plate*," and was used while burning some of samples of bituminous coal, which were so fine that large portions liable to pass through the grate. With this plate in place, and the plate in its usual position, the size of the grate was reduced to 11.375 sq feet, and the heated to the grate surface increased to $\frac{377.5}{11.375}=33.18$ to

"On one occasion, instead of contracting the area of the grate by m of the coking plate, it was diminished by placing a row of bricks flat along each side of the furnace, reducing the grate surface to 10.291 squ feet, and the ratio of *heated* to *grate* surface to $\frac{377.5}{10.291}=36.68$ to 1.

Depth of fire.

"The grate was, in general, about 9 inches at the front, and 10 in at the back end, below the lower arch of the boiler. On one or occasions, however, which are noted in the tables of experiments, it varied a little from this distance; but as no advantage appeared to at the change, it was restored to this, as the most convenient wor distance for all the varieties of fuel employed.

Grate-bars.

"The grate-bars used were three-fourths of an inch thick, and the sp between them half an inch wide. They were supported at the centre well as at each end, by a cast-iron bar 2½ inches thick, and 4 inches d Hence, when the grate was at its full size, the total amount of air pass through the grate was nearly 5⅝ square feet.

Capacity of boiler.

"The interior capacity of the boiler was such as to contain, when fi to the centre of the gauge-tube, or *normal* level of the experiments, water of 66° temperature, 12,795 lbs. This is the result of an experim made after clearing out and wiping dry the interior of the boiler, refilling it through the measuring-cistern. Of this quantity, 493 pou were then withdrawn, leaving 12,302 pounds, filling the boiler to wit 1.1 inch of the normal level. On subsequently heating this to 230°, water in the gauge, after taking all due precaution to withdraw the c water from the glass tube, and filling it with that which was hot, st once more at the normal level. Hence the apparent expansion of wate iron, by an addition of 164 degrees of heat, is equivalent to $\frac{493}{12302}=0.04$ or a little more than one twenty-fifth part of its bulk at 66°."*

* Report on American Coals, pp. 12-13.

The details of supply of water, gauges and discussions of the method conducting the experiments, though of very great scientific interest, cupy too much space to be given here. I shall therefore proceed to the sults of the experiments, using as nearly as possible the arrangement of original report. All the facts which follow, are taken from Johnson, d where advisable, his report is quoted *verbatim*. Other details omitted.

Under Class IV, (p. 452) of the Report, Professor Johnson includes: Foreign bituminous coals, and those of similar constitution West of the leghany Mountains." Among the foreign coals, he includes:— Classification of Pictou coals.

1. Pictou, (purchased in New York.)
2. Sydney.
3. Pictou, (Cunard's.)
4. Liverpool.
5. Newcastle.
6. Scotch.

Johnson's Class IV.

In description of the general characters of these coals, he says:—"In ny respects this class of coals bears a strong analogy to the preceding.* e ratio of the fixed to the volatile combustible matter is, however, nething less. The exterior presents often a resinous lustre. The sures of deposition are easily developed by fracture. Great facility of ition and a high degree of activity in the combustion of their volatile stituents, are also general properties of this class. Their high propor- of volatile combustible matter renders these coals, when nearly free m sulphur, eminently suitable for the production of illuminating gas; and tendency of their cokes, with few exceptions, to intumesce strongly, ders them, in common with the preceding class, highly serviceable for ning large hollow fires for smithing purposes." General characters.

(*Copy.*)

No. 1.

uminous coal from Pictou, Nova Scotia, procured from Messrs. Laing & Randolph, in New York, for comparative experiments.

This coal has a glimmering lustre, or a dull aspect, according to the t observed. The surfaces of deposition are, in some specimens, ined at an angle of 83° to the main partings; thin scales of earthy ter are occasionally found in the joints, or vertical seams; but, in eral, little impurity is observable on the exterior. Conchoidal fraces are of unfrequent occurrence. The coal was of average size, lumps fine being intermixed in due proportion, to constitute a merchantable cle for ordinary use in smith's fires, and for domestic purposes. The Trial of the coal bought in New York.

Class III. Bituminous coking coals from the eastern coal-fields of Virginia in the ghbourhood of Richmond. (Report, pp. 308-541.)

powder of this coal is of a dark brown colour, and its streak on a earthern ground is of the same tint.

The specific gravity of one specimen (*a*) was 1.3546 ; that of an (*b*) 1.2807 : from the mean of which, the calculated weight per foot is 82.35 pounds.

By 39 trials in the charge-box, the greatest weight of any one c was 112.25 pounds, or 56.125 lbs. per cubic foot. The least weig 97.5 lbs. per charge, or 48.75 lbs. per cubic foot; while the aver the whole was 53.548, or 0.6502 of the above calculated weight. space for the stowage of one ton of the coal is 41.832 cubic feet.

The moisture in specimen *a* was 0.97 ; and that in *b*, 0.935 per c

The volatile matter, other than moisture, in *a*, was 27.51 ; the su 0.7689 per cent.

The volatile matter, other than moisture in *b*, 20.105.

Four incinerations of *a*, gave of *ashes* 2.38 ; and the same numbe 2.65 per cent. Hence the composition is as follows, viz :—

Analysis.

	Specimen *a*.	Specimen *b*.
Moisture	0.970	0.935
Sulphur	0.769	(not tried.)
Other volatile matter	26.741	20.105
Earthy matter	2.380	2.650
Fixed carbon	69.140	76.310
	100.	100.
The volatile to fixed combustible	1 : 2.5132	1 : 3.7955

Two specimens of this sample of coal were assayed by Dr. Kin yielded, the one 36, and the other 33, per cent. of volatile matter, incl moisture. These, combined with the above, give a mean of 29.63, may probably be assumed as a pretty near approximation to the a yield of this ingredient.

By exposure for four days in the steam-drying apparatus, 28 p of this coal lost 0.71875 lbs. of moisture, or 2.567 per cent.

During the four trials of evaporative power, 4153.875 pounds burned, and yielded 302.4 lbs. of ashes, (including those of 408.6 of pine wood,) 253.475 pounds of clinker, and 19.5 pounds of soot. ashes lost by re-incineration 5.907, and the soot 65.42, per cent. of weight.

Hence the absolutely incombustible materials are—

From the ashes	284.540	pounds.
" clinker	253.475	"
" soot	6.743	"
Total	544.758	"
Deduct for wood ashes	1.227	"
Leaves	543.531	"

ich is 13.389 per cent. of the coal burned.

3y these data we may assign the following as the proximate constituents this sample; viz. :— Practical analysis.

Moisture, (from 28 lbs.)	2.567	per cent.
Other volatile matter, (mean of 4 specimens)	27.063	"
Earthy matter (from 4153.87 lbs.)	13.389	"
Fixed carbon	56.981	"
	100.	

Volatile to fixed combustible ... . 1 : 2.1054

'he above result in earthy matter, derived from a sample of two tons, ibits a striking contrast with the analyses of single hand-specimens.

'he clinker is of a dark reddish-brown colour, in sheets of considerable gnitude, somewhat porous; small shaly fragments are intermixed, and etimes adhere to the vitrified masses. It weighed 43.12 pounds per ic foot, and gained weight by calcination equal to 0.84 per cent., ing the powder of a light brown, with its finer parts bright red. Clinker.

'he weight of the ashes, as they came from the furnace, was 38.56 lbs. cubic foot; and the residue of their re-incineration had a colour nearly 1-red, while that from the soot was reddish-grey—a shade lighter than from the ashes. Ash.

'he ashes from specimens *a* and *b* are of a purplish-red colour, with ks of white.

'ried with the oxide of lead, 20 grains of specimen *a* gave 544.8 grains metallic lead, or 27.24 times its weight. Deducting moisture and hy matter, this gives to one of combustible matter 28.184.

n a smith's fire for ordinary work, this coal afforded a rather dull comion; made a good hollow fire; left a fair coke, not unusually hard; luced a large quantity of cinder, and gave a tolerably fair heat.

n the chain-shop, it gave a heavy flame; formed a coke too hard to be ly broken up, as the work requires; was rather hard and unmanage-, and left a large proportion of cinder. Sixty pounds made but 11 s of a chain 1⅝ inch in diameter; while several other coals, tried by same workman on the same chain, were found adequate to the making rom 13 to 20 links, by the same weight of coal. Trial for chain making.

* * * * * * * *

he ignition of this coal is easily effected. It took, on an average of trials, only 0.937 hour, or 56¼ minutes, to bring the boiler to a state teady action. In conformity with this fact, is that relative to the irnt coke, which was, on an average, only 5.689 lbs. at each trial.*

*Here follow tables giving the details of all the experiments; from which the deduc- in the table on the next two pages are taken. It is extracted *verbatim* from son's Report.

DEDUCTIONS FROM TABLES CLV, CLVI, CLV

Experiments on F

		Nature of the data furnished by the respective tables.	1st Trial. (*Table CLV.*)	2d Tri (*Table CL*
			August 30.	*August*
Results of Trial No. 1, Class IV.	1	Total duration of the experiment, in hours............	22.033	23.9
	2	Duration of steady action, in hours..................	6.333	6.3
	3	Area of grate, in square feet	14.07	14.0
	4	Area of heated surface of boiler, in square feet........	377.5	377.5
	5	Area of boiler exposed to direct radiation, in square feet.	18.75	18.7
	6	Number of charges of coal supplied to grate	9.0	10.0
	7	Total weight of coal supplied to grate, in pounds......	978.50	1071.7
	8	Pounds of coal actually consumed..........	974.88	1069.6
	9	Pounds of coal withdrawn and separated after trial...	3.62	2.1
	10	Mean weight, in pounds, of one cubic foot of coal.....	54.361	53.5
	11	Pounds of coal supplied per hour, during steady action.	120.77	119.6
	12	Pounds of coal per square foot of grate surface, per hour.	8.583	8.5
	13	Total waste, ashes and clinker, from 100 pounds of coal.	13.714	12.9
	14	Pounds of clinker alone, from 100 pounds of coal......	6.6911	6.2
	15	Ratio of clinker to the total waste, per cent..........	48.788	48.0
	16	Total pounds of water supplied to the boiler..........	7759.0	8340.0
	17	Mean temperature of water, in degrees Fahrenheit.....	82°.8	83°.0
	18	Pounds of water supplied at the end of experiment, to restore level..................................	782.0	550.0
	19	Deduction for temperature of water supplied at the end of experiment, in pounds........................	99.0	69.0
	20	Pounds of water evaporated p. hour, during steady action	882.36	908.8
	21	Cubic feet of water per hour, during steady action....	14.12	14.5
	22	Pounds of water per square foot of heated surface per hour, by one calculation..........................	2.337	2.4
	23	Pounds of water per square foot, by a mean of several observations....................................	2.347	2.3
	24	Water evaporated by 1 of coal, from initial temp. (a) final result..................................	7.858	7.7
	25	Water evaporated by 1 of coal, from initial temp. (b) during steady action..........	7.301	7.5
	26	Pounds of fuel evaporating one cubic foot of water....	7.9537	8.0
	27	Mean temperature of air entering below ash-pit, during steady pressure..................................	92°.59	92°.3
	28	Mean temp. of wet-bulb thermo., during steady pressure	79°.08	80°.6
	29	Mean temperature of air, on arriving at the grate......	254°.92	259°.1
	30	Mean temp. of gases, when arriving at the chimney....	301°.25	334°.6
	31	Mean temperature of steam in the boiler.............	229°.54	229°.5
	32	Mean temperature of attached thermometer...........	84°.88	86.9
	33	Mean height of barometer, in inches..................	30.161	30.0
	34	Mean number of volumes of air in manometer.........	5.225	5.2
	35	Mean height of mercury in manometer, in atmospheres.	0.5342	0.5
	36	Mean height of water in syphon draught-gauge, in inches	0.2907	0.3
	37	Mean temperature of dew-point, by calculation........	75°.9	77°.5
	38	Mean gain of temp. by the air, before reaching grate...	162°.61	166°.5
	39	Mean difference between steam and escaping gases....	71°.71	105°.1
	40	Water to 1 of coal, corrected for temperature of water in cistern..	7.8258	7.7
	41	Water to 1 of coal, from 212°, corrected for temperature of water in cistern.............................	8.8059	8.6
	42	Pounds of water, from 212°, to 1 cubic foot of coal....	478.74	464.3
	43	Water, from 212°, to 1 pound of combustible matter of the fuel......................................	10.2055	9.9
	44	Mean pressure, in atmospheres, above a vacuum......	1.4213	1.4
	45	Mean pressure, in pounds p. sq. inch, above atmosphere	6.2219	6.3
	46	Condition of the air-plates, at the furnace-bridge	Open.	Closed
	47	Inches opening of damper, (U. upper)...............	U. 8	U. 8

CLVIII, OF JOHNSON'S REPORT, PAGES 456-463.

coal (from New York.)

3rd Trial. (*Table CLVII.*)	4th Trial. (*Table CLVIII.*)	Averages.	Remarks.
September 1.	*September* 2.		
23.95	23.05		
10.00	7.083		
14.07	14.07		
377.5	377.5		
18.75	18.75		
11.0	9.0		
1179.5	947.0		
1166.61	942.89		
12.89	4.11	5.6895	
53.614	52.611	53.5434	
96.9	104.01	110.342	
6.887	7.392	7.842	
13.195	13.642	13.3712	
5.2321	6.3657	6.1257	
39.651	46.658	45.7916	
8743.0	6661.0		
84°.1	82°.7		
575.0	547.0		
72.0	69.0		
721.9	684.59	799.432	
11.55	10.953	12.7908	
1.912	1.813	2.1172	
1.893	1.794		
7.432	7.009	7.508	With damper drawn 8 inches, the first trial gave, with a clean surface of boiler and flues, and the air-plate open, 7.858 of water to 1 of coal; the second, with the same plate closed, and surfaces with one day's impurity on the flues, 7.733, or 1.6 per cent. less.
7.449	6.5802	7.231	
8.4096	8.9171	8.3407	
89°.8	90°.33		
79°.21	78°.87		
282°.05	278°.8	268°.724	
315°.42	306°.71	308°.702	
231°.0	228°.6		
85°.71	83°.0		
30.080	30.104		
5.227	5.247		
0.5343	0.5323		
0.2845	0.2443	0.2818	
75°.53	75°.7		
191°.72	189°.0	177°.466	
85°.33	77°.77	84°.69	
7.4009	6.9803	7.4771	
8.3207	7.8545	8.4117	
446.10	413.23	450.612	
9.5855	9.0953	9.7099	In the fourth trial, the decided inferiority of effect to the preceding is probably to be ascribed to the coating of soot upon the flues, and the want of sufficient draught to burn completely the products of combustion.
1.4219	1.4122	1.421	
6.231	6.0876	6.2182	
Open.	Closed.		
U. 4.	U. 4.		

(Copy.)

No. 3.

Bituminous coal from Pictou, Nova Scotia, sent by Mr. Cunard, agent the General Mining Association of London.

Trial of sample from agents.

The coal of this sample is, in every external character, entirely similar that from the same mining district obtained from New York. The speci gravity of one specimen (*a*) was 1.3155; that of another, (*b*,) 1.335 The mean of these makes the weight of the cubic foot in the solid sta 82.835 pounds. The actual weight, determined by 20 trials in the charg box, is for the least 45.5, for the greatest 52·125, and for the avera 49.25 pounds per cubic foot, or 0.5945 of the calculated weight. Hen the space to receive one ton is 45.482 cubic feet.

The moisture expelled by thoroughly drying specimen *b* was 1.079.

The coking of *a* caused a loss, including moisture, of 26.413 per cer The process having been conducted very slowly, the powder did n become agglutinated; but another portion of the same powder sudden exposed to a bright red heat, became converted into a well-formed ma Of specimen *b*, a portion coked so slowly, and at so low a heat, that t gas did not take fire, exhibited a loss of 27.1 per cent. Another portion the same powder, coked rapidly, so as to become completely coalesce lost 29.34 per cent.

The earthy matter in *a* was 10.09, in *b* 11.404 per cent. Hence t proximate constituents of these two specimens are—

Analysis.

	Specimen *a*.		Specimen *b*.	
Moisture........	(not separately determined)		1.079	
Volatile matter...........	26.413	other than moisture	26.021	by slow coking.)
Earthy matter...........	10.090		11.404	
Fixed carbon............	63.497		61.496	
	100.		100.	
Volatile to fixed combustible	1 : 2.404		1 : 2.3633	

The moisture expelled from 28 lbs., dried in the steaming-apparatu amounted to 0.7812 per cent. The volatile matter, including moistur from the mean of the two specimens above given, is 26.756.

During the two experiments on evaporation, there were burned 1962 pounds of this coal, and the—

Weight of ashes withdrawn was..........	116.00	lbs.
of clinker............................	121.75	"
of soot............................	8.75	"

The ashes lost 0.04077 of their weight, and the soot 0.60144, by re-incineration. Reducing the weights of these two, and deducting 1.029 lbs., for the ashes of 355.25 lbs. of pine wood, we have left 245. 481 lbs., for the total waste from the above weight of coal, or 12.508 per cent.

From these data it would seem that the coal is composed of—

Practical analysis.

Moisture, (from 28 lbs.) - -	-	0.7812
Other volatile matter, (from two specimens)	-	25.9753
Earthy matter (from 1962.5 lbs.) -	-	12.5085
Fixed carbon, (calculated by difference)	-	60.7350
		100.

Volatile to fixed combustible 1 : 2.5929.

The ashes weighed	39.01	lbs. per cubic foot.		
The clinker	"	38.00	"	"
The soot	"	3.82	"	"

Clinker.

When re-incinerated or calcined, the clinker became of a dark drab or light brown colour, the ashes of a light reddish-gray, and the residue of the soot a light drab colour. The ashes from analysis of *a* were pure white; from *b*, dirty white.

The clinker, as it came from the furnace, was black, vitreous, and porous, in masses tolerably friable, and not apparently prone to adhere to the grate. Much shaly matter attaches itself to the vitrified portions.

With the oxide of lead, specimen *b* gave 23.355 times its weight in metallic lead. Deducting moisture and earthy matter, we have left 0.87517 of combustible; by which, dividing the above, we get $\frac{23.355}{.87517}=$ 26.686.

For the reason assigned in regard to the preceding sample which accompanied this, the trial in smith's forges and in open grates was necessarily dispensed with. This is the less to be regretted in the present instance, as the sample of Pictou coal already described has been tested in the forge; and as the action of the two samples is in other respects almost identical, there is no reason to doubt that in this particular also they would be found to coincide.

The mean time required to bring the boiler to a steady rate of evaporation was 0.85 hour, or 51 minutes. The weight of coke left unburnt on the grate was very small, being on the first trial, 5 pounds, and on the second 2.5. The combustion commenced promptly, and the flame was long, and accompanied by considerable smoke. The large amount of clinker (more than 50 per cent. of the total waste) rendered it necessary to remove the heavier masses within a few hours after the fire was kindled.

DEDUCTIONS FROM TABLES CLXIII, CLXI

Experiments o

Results of Trial. No. 3. Class IV.

	Nature of the data furnished by the respective tables.	1st Trial. (*Table CLXIII*)	2d Trial. (*Table CLXIV.*
		September 27.	*September 28*
1	Total duration of the experiment, in hours..........	25.083	24.383
2	Duration of steady action, in hours..................	5.267	5.333
3	Area of grate, in square feet.........................	14.07	14.07
4	Area of heated surface of boiler, in square feet........	377.5	377.5
5	Area of boiler exposed to direct radiation, in square feet	18.75	18.75
6	Number of charges of coal supplied to grate..........	10.0	10.0
7	Total weight of coal supplied to grate, in pounds.....	992.25	977.75
8	Pounds of coal actually consumed..................	987.25	975.25
9	Pounds of coal withdrawn and separated after trial...	5.0	2.5
10	Mean weight, in pounds, of one cubic foot of coal.....	49.6125	48.8875
11	Pounds of coal supplied per hour, during steady action	149.212	127.648
12	Pounds of coal per square foot of grate surface, per hour	10.6	9.072
13	Total waste, ashes and clinker, from 100 pounds of coal	11.62	12.505
14	Pounds of clinker alone, from 100 pounds of coal......	5.7655	6.6199
15	Ratio of clinker to the total waste, per cent..........	49.347	52.935
16	Total pounds of water supplied to the boiler..........	7545.0	7204.0
17	Mean temperature of water, in degrees Fahrenheit.....	70°.5	67°.3
18	Pounds of water supplied at the end of experiment, to restore level..................................	270.0	406.0
19	Deduction for temperature of water supplied at end of experiment, in pounds..........................	37.0	57.0
20	Pounds of water evaporated p. hour, during steady action	1122.86	936.68
21	Cubic feet of water per hour, during steady action.....	17.96	14.987
22	Pounds of water per square foot of heated surface per hour, by one calculation........................	2.974	2.481
23	Pounds of water per square feet, by a mean of several observations..................................	2.988	2.498
24	Water evaporated by 1 of coal, from initial temp. (a) final result..................................	7.6049	7.328
25	Water evaporated by 1 of coal, from initial temp. (b) during steady action	7.522	7.338
26	Pounds of fuel evaporating one cubic foot of water....	8.2174	8.529
27	Mean temperature of air entering below ash-pit, during steady pressure..............................	64°.15	64°.33
28	Mean temp. of wet-bulb thermometer, during steady pressure	55°.08	55°.8
29	Mean temperature of air, on arriving at the grate	209°.15	233°.13
30	Mean temp. of gases, when arriving at the chimney...	295°.0	330°.0
31	Mean temperature of steam in the boiler.............	231°.0	232°.0
32	Mean temperature of attached thermometer...........	62°.115	59°.67
33	Mean height of barometer, in inches.................	30.146	30.249
34	Mean number of volumes of air in manometer.........	5.0246	5.004
35	Mean height of mercury in manometer, in atmospheres.	.5546	.5572
36	Mean height of water in syphon draught-gauge, in inches	.3241	.3525
37	Mean temperature of dew-point, by calculation........	46°.78	48°.63
38	Mean gain of temp. by the air, before reaching grate..	145°.0	168°.8
39	Mean difference between steam and escaping gases....	67°.66	107°.06
40	Water to 1 of coal, corrected for temp. of water in cistern	7.5864	7.3148
41	Water to 1 of coal, from 212°, corrected for temperature of water in cistern..........................	8.6249	8.3446
42	Pounds of water, from 212°, to one cubic foot of coal..	427.9	407.94
43	Water, from 212°, to one pound of combustible matter of the fuel	9.7589	9.5373
44	Mean pressure, in atmospheres, above a vacuum......	1.4389	1.4408
45	Mean pressure, in pounds p. sq. inch., above atmosphere	6.4819	6.5104
46	Condition of the air-plates at the furnace-bridge......	Closed.	Open.
47	Inches opening of damper, (U. upper)...............	U. 8.	U. 8.

OF JOHNSON'S REPORT, PAGES 478-481.

Pictou (N. S.) coal, (Cunard, agent.)

Averages.	Remarks.
3.75	In a very close approach to total combustion, as well as in many other of its properties and modes of action, this sample manifests its affinity with the Pictou coal procured in New York.
49.25	
138.43	
9.836	
12.0625	
6.1927	
51.141	
1029.77	The rate of evaporation with air-plate open is 16.5 per cent. less rapid than with the plate closed.
16.4735	
2.7275	
7.4664	
7.43	
8.3732	
221°.14	
312°.5	With the air-plate open, as in the second trial, the gases going to the chimney had a temperature 35° higher than with the same plate closed, as in the first experiment. The considerable coating of soot on the flues may have helped to keep the gases at their high temperature, and to diminish the evaporative effect, as seen in lines 41 and 43.
.3383	The second trial had the advantage of a stronger draught than the first.
156°.9	
87°.33	
7.4506	
8.4848	
417.92	
9.6481	
1.4398	
6.4962	

DRUMMOND COAL ON QUEBEC STEAMERS.

Drummond coal on Quebec steamers.

No opportunity for making a steamer-trial of the Drummond coa offered during last season, but a few facts concerning the success wit which it is used on the Quebec and Gulf Ports Steamship Company' steamers, "*Secret*," "*City of Quebec*," and "*Gaspé*," may not be ou of place here. These steamers run from Quebec to Pictou, touching a Gaspé, Baie des Chaleurs, and several other points on the Gulf of St Lawrence. The following information was obtained through Mr. A. P Ross, of Pictou, agent Q. and G. P. SS. Co., (to whom my thanks are due for his interest in this matter,) by sending blank forms to the engineer of the different steamers, including questions and suggestions, which forms being filled up with the requested information, were returned to me Without including the questions, or adhering to the words of the origina blanks, a general abstract* will be given of their contents.

STEAMSHIP "SECRET."

Form filled up and signed by Thomas D. Finegan, engineer.

SS. "Secret."

Steamship "Secret" is 622 tons register. Her engines are oscillating, two cylinders 50 inches diameter, 54-inch stroke. Two boilers; close bottom; return tubes. Working pressure of steam from 17 to 20 lbs.

This steamer has used Drummond coal about five months (Nov., 1869.) The quantity taken on board per trip is from 105 to 137 tons, and about 27 tons are used per day. In comparison with other coals, Mr. Finegan states:—"I have found in practice, 20 tons of best Welsh coal, in evaporative power, are equal to 27 tons Intercolonial (Drummond) coal, and 27 tons Intercolonial coal equal to 30 tons Scotch. All things considered, I would rather have Intercolonial coal." His further statements indicate:— That if the opening between the grate-bars of the steamer-furnace are only from $\frac{3}{4}$ to 1 inch apart, no slack is wasted by falling through the grate unconsumed; that the coal cakes but little on the grate; that but little clinker is formed, but that what there is, is in sheets of some thickness; and that compared with the English and Scotch coals as used on the steamer, this coal gives "considerably more" ash. In answer to the final question: "Is there anything else you can think of, either for or against the coal?" Mr. Finegan states: "Intercolonial coal has given me good satisfaction, all things considered. I look upon it as good quality steam-coal. Leaving so large an amount of ash occasions much extra work, but this is more than compensated by the saving in grate-bars, which are no small item of expense, and they last much longer with this coal, than when Welsh (or many other) coals are used."

STEAMSHIP "CITY OF QUEBEC."

Information received from Thomas Palaquie, engineer.

Steamship "City of Quebec" is 499 tons register. Engines oscillating, with two cylinders 57 inches diameter × 56 inches stroke. Two boilers with eight fires. Working pressure of steam, 18 lbs. SS. "City of Quebec."

The Drummond coal has been used on this steamer since 17th May, 1869, (Nov., 1869.) The quantity taken on per trip is about 130 tons, and with eight fires and running at full speed, about 36 tons are used per day.

The coal generally burns well, not falling to pieces when thrown on a hot fire, and not caking. It forms clinker in sheets, but this clinker does not stick to the bars, and the ash, which is white, is about twice the quantity produced by English or Scotch coal.

STEAMSHIP "GASPE."

Form filled up and signed by John Campbell, engineer.

The steamship "Gaspé" is of 231 tons register. She has oscillating engines (two cylinders 32 inches diameter × 3 feet stroke), and one tubular boiler. When this information was furnished (Nov., 1869), the Drummond coal had been used but two trips on this steamer. The quantity of coal taken in per trip stands as follows:—At Quebec, 70 tons Scotch; at Pictou, from 63 to 65 tons Intercolonial (Drummond); the amount of the last burnt per day, equalling about 12 tons. S. S. "Gaspe."

In comparison with other coals, Mr. Campbell states:—

"I find that Intercolonial coal lasts longer than Scotch; in proof of this: 4th trip from Quebec, 65 tons Scotch, 109 hours running time; 4th trip up, 58 tons "Intercolonial," 118 hours running time; 5th trip down, 62 tons Scotch, 98 hours. You will see that we ran 118 hours with 58 tons Intercolonial, against 65 tons Scotch coal in 109 hours."

Further statements indicate that no inconvenience is felt from the slack falling through the grate, when the bars are properly pitched; that the coal cakes on the grate when damp; that it forms whitish-brown clinker in sheets which does not adhere to the bars; and that it leaves a considerable quantity of yellowish-gray ash, which is "sometimes nearly black."

PICTOU COALS ON OCEAN STEAMERS.

For some months past, coals from the Acadia-West and Drummond collieries have been used on the large ocean-steamers of the Montreal Ocean Steamship Company (Allan's line), on the homeward voyages from Montreal in summer and Portland in winter, to Liverpool and Glasgow. Trials on the Allan Line of Steamships.

The regular supply of coal has, I believe, been furnished by the Acadia colliery (Acadia steam-coal), though several thousand tons of Intercolonial (Drummond) coal have also been used. Through the kindness of Messrs. H. & A. Allan, I have been allowed to examine the reports of the engineers of a number of their steamers, concerning comparative trials of these coals (as supplied at Montreal and Portland), with the Welsh steam-coals supplied for the outward voyages, at Liverpool, and have permission to include the more important results of these trials in this Report. The general result appears to be satisfactory, except in one particular, viz.:—the large amount of ash produced; but the inconvenience felt from this cause is in most cases counterbalanced by the small amount of sulphur in the coals, the absence of adherent clinker, and the consequent preservation of grate-bars.

Daily consumption.

Consumption, as compared with Welsh.—The record of comparative daily consumption of these and Welsh coals during some of the trials, is as follows:—

1. S.S. "Peruvian," (Report Jan., 1869.)
   63 tons 10 cwt. Acadia = 50 tons 10 cwt. Welsh = 57 tons 10 cwt. mixture of the two coals = 124:100:115.
2. S.S. "Nestorian," (Report 1st Feb., 1869.)
   68 tons Intercolonial = 55 tons Welsh = 123:100.
3. S.S. "Hibernian," (Report 9th Feb., 1869.)
   62 tons Pictou (principally Intercolonial,) = 50 tons Welsh = 124:100.
4. S.S. "Nestorian," (Report 17th Feb., 1869.)
   69 tons Intercolonial = 59 tons Welsh, (pressure of steam being as 18:25.) This (taking steam-pressure into consideration,) = 162:100.
5. S.S. "Hibernian," (Report 1st March, 1869.)
   58½ tons mixed Acadia and Intercolonial = (estimated) 51 tons Welsh as received in Portland, or 48 tons as received in Liverpool = 121:106:100.
6. S.S. "North American," (Report has no date.) It states that 45 tons of Acadia coals are consumed per day, being same consumption as with Welsh, but pressure of steam is 4 or 5 lbs. less than with Welsh. If pressure of steam with Welsh = 25 lbs. (?), then ratio of Acadia and Welsh would = 118:100.
7. S.S. "Nestorian," (Report of 28th March, 1870.)
   66 tons Acadia = 59 tons Welsh coal, steam-pressure being 22½:25 lbs. This indicates the ratio of 122:1·00, taking steam-pressures into consideration.

AVERAGE RATIOS OF DAILY CONSUMPTIONS, FROM ABOVE TRIALS.

1. Welsh* to Acadia	100.0 : 121.3	Comparison Pictou and Welch coals.
2. " " Intercolonial, including trial No. 4.†	100.0 : 136.3	
3. " " Intercolonial, rejecting trial No. 4	100.0 : 123.5	
4. " " mixture, Welsh and Acadia	100.0 : 115.0	
5. " Acadia and Intercolonial	100.0 : 121.0	
6. " " Welsh as delivered in Portland	100.0 : 106.0	

Ashes and Clinker.—Mr. Flett, chief engineer of the S.S. *Peruvian*, in his Report of June, 1869, says :—"There is a large quantity of ashes from the Acadia coals, but little clinker, which enables us to clean the fires easily, as nothing sticks to the bars." Mr. Dick, chief engineer of the S.S. *Hibernian*, says :—"The fires are easily cleaned, that is, the clinkers do not stick to the bars, neither do they burn the bars." The other engineers complain of more or less clinker from both Acadia and Intercolonial coal; the Acadia, however, appears to give the least trouble in this respect. This is owing to the fact that the Intercolonial coal is the softest, and if not properly stoked would be inclined to clinker. The fact that some engineers burn these coals without clinker, is sufficient proof that it is possible to do so in every case. As I shall presently show, it is probable that, if these coals are burnt with a fire, thin at the bridge, deep at the fire-door, with proper perforations in the door, (equalling at least 8 or 10 square inches per square foot of door,) there should be no difficulty in keeping good steam, and avoiding the large flat clinkers which are complained of; but attempts to burn these caking coals on a thin flat fire such as is generally made in burning Welsh steam-coals, which are not inclined to cake, will never result in success. Ash and clinker.

The amount of refuse from these coals in proportion to Welsh, is variously estimated by the different engineers; the average seems to be, in buckets thrown overboard perwatch of four hours :—Welsh, from 15 to 18; Pictou, from 35 to 45.

Smoke, etc.—The only mentions made of smoke in these reports occur in the reports of Messrs. Jack, of the *Hibernian*, and McMaster, of the *Nestorian*, both of whom complain that when urging the fires to get all the steam possible, large volumes of smoke and flame are seen coming from the funnel. I need hardly say that this manifestly results from an improper arrangement of the draught, and it would appear from this that no air is supplied above the fire, to assist in burning the volatile matters passing off from the coal in coking, previous to combustion. This must result in a great loss of coal, and can be partially remedied by the same change in Smoke.

* Welsh, "best Welsh steam-coal, delivered in Liverpool."

† The low result of trial No. 4 is probably due to bad management of the coal. It is so discordant with other results that I think it should be rejected.

management mentioned above, viz.:—proper stoking, and perforated doors. This subject will be further considered under the next heading, paragraph "*Smoke consumption.*"

GENERAL REMARKS ON STEAM-TRIALS.

General remarks on steam trials.

The general result of all the trials above described has been to demonstrate the fitness of the coals used, for steam production, whether under stationary marine or locomotive boilers. As the result of each separate trial can be compared with similar trials of foreign coals, by reference to any work on standard coals or engineering practice, it seems unnecessary to make any such comparison here.

Former prejudices against bituminous coals, as steam producers.

A few remarks on late experiments on the consumption of such coals, however, may not be out of place, but though of very great importance to our coal trade, a full discussion of the subject will not be practicable without extending this Report far beyond the limits to which it must be necessarily confined. A prejudice existed for a long period against using bituminous coals as steam-producers, especially in the Navy, on account of the large amount of smoke produced in burning them, and their low evaporative power, as compared with anthracites, or the so-called free burning coals of the Welsh coal-fields. The heavy black smoke emitted from the funnel of a steamer burning these coals rendered them quite unfit for the use of ships of war, and in towns and cities became a serious nuisance. Their evaporative powers, as has already been stated, were supposed to be dependent on their content of fixed carbon, which supposition seemed to be quite justified by practical experiments. The most careful trials with the old style of furnaces failed to give them the value of the Welsh steam-coals, in proof of which I may cite the final results of the British experiments (De la Beche and Playfair's), in evaporative powers:—

Average of	37	samples	from	Wales	9.05 lbs.
"	17	"	"	Newcastle	8.37 "
"	28	"	"	Lancashire	7.94 "
"	8	"	"	Scotland	7.70 "
"	8	"	"	Derbyshire	7.58 "

Resemblance of Pictou and North Country coals.

Of the above list of coals, the coals of the Pictou district approach nearer to the Newcastle Hartley, or North Country coals than to any other class well known, and it will be, therefore, of the greatest interest to show the change of opinion which has taken place with regard to these coals within the last few years; to mark how all the old prejudices have disappeared, and to ascertain with what success these coals are now consumed as steam-producers.

To accomplish this object in the most direct manner, I cannot do better

than quote from the "Report of a Committee appointed by the North of England Institute of Mining Engineers, to investigate the smoke question" (dated Oct. 24th., 1860.) After mentioning the causes that led to the appointment of this committee, they state :— Smoke consumption.

"They (the Committee) cannot, however, forbear remarking that there is really very little left for them to do. A few years ago, in 1855, there was an impression that North Country steam-coal not only made smoke when burnt, but was of an inferior evaporative power to that of the so-called smokeless Welsh coal. Since then, on two subsequent occasions, this has been proved, most satisfactorily, to be an error. In 1856-7, experiments were made at Elswick, conducted by Sir William Armstrong, Mr. J. A. Longridge and Dr. Richardson, which fully demonstrated that Hartley could give, without smoke, 12.9 lbs., and Welsh 12.35 lbs. of water evaporated from 212°, per pound of coal, in an ordinary marine boiler ; and in 1864, Mr. Miller, at the request of the House of Commons, made a series of experiments which proved again most satisfactorily that Hartley could give without smoke 10.68 lbs., and Welsh 10.13 lbs. of water evaporated from 100 per pound of coal. Again, at Wigan, in 1867, Messrs. Fletcher and Dr. Richardson conducted a series of experiments proving most conclusively that a bituminous coal, more difficult even to manipulate in the fire than the coal of this district, can be economically and *smokelessly* consumed. All these results have been accomplished with the smallest possible alteration of the furnace and bars of ordinary marine boilers. Your Committee, therefore, have, from many and various sources, the highest authority for stating that, as far as experiments can do so, the question is practically *solved*, and more particularly in connection with any ordinary quality of round coal, and in Cornish or marine boilers of ordinary construction. It could hardly be expected that any further experiments would produce better or more conclusive results, or be attested by gentlemen of higher reputation and position. Lake experiments.

* * * * * * * * * * *

"Believing, as they do, that the semi-bituminous steam-coal of this district can be burnt without smoke, so as to give as high, if not a higher and more speedy evaporative power, than Welsh (as might be expected from its chemical composition), your Committee can by no means aver that this most important fact is comprehended by the great bulk of consumers ; but they are not of opinion that any further experiments in this direction are necessary, as it seems to them that data on this subject are so numerous already, that the public may be properly left to draw their own inferences thereon.

"If your Committee were asked for the reason for so much incredulity on a subject so important to the interests of the Northern coal-owners, they

would suggest that it, to a certain extent, arises from the fact that th steamships built in the neighbouring ports are not, as a rule, by any mean successful either in their attempts to prevent smoke, or to obtain th highest results from the coal of the district. These steamers, going fron port to port, and from country to country, assist in advocating the view of those who refuse to recognise the value of the Northern steam coals and your Committee regret that the boilers of these ships at least are no constructed so as to bear out the results so laboriously obtained at sucl great cost."*

Many of the statements in the above extract will apply with almost equa force to our own coals. It is scarcely possible that we shall obtain th very high results in evaporative power above indicated, from the Picto coals, from the fact that the amount of ash in these coals almost invariabl exceeds that in the coals of the North of England; but it is certain tha with proper furnaces, the evaporative power of our coals may be materiall increased, probably to the extent of from twenty-five to thirty per cent., an there seems no reason to doubt, that, in the matter of smoke, our coals ma be as successfully burnt as those of the North Country.

Mr. Bunning's experiments.

In this connection it will be interesting to examine into the success wit which the Newcastle coals are burnt without smoke, and to this end, an abstract of the experiments of Mr. T. W. Bunning, of Newcastle-on-Tyne on the steamer "*Weardale*," will most conclusively show the wonderful improvements made from the results of the old system of burning the coals, by a very slight change in the furnaces and bars. A series of smoke-trials were made on this steamer with the ordinary furnace, fitted with grate-bars five feet long, and the exact amount of smoke produced by Hartley coal was obtained by a method presently to be described. An alteration was then made in the furnaces, which consisted simply in shortening the bars to three feet six inches, and introducing an *air-plate* (of fire-bricks with open spaces between them, hung on iron bars), at the back of the fire. Underneath this air-plate was a flue, or open space, separated from the ash-pit of the furnace by a cast-iron plate, carrying the brick forming the bridge proper of the furnace. This cast-iron plate was pierced with a hole giving communication between the ash-pit and air-plate flue, when open, and thus admitting air between the fire and the chimney, through the spaces between the fire-brick forming the air-plate; or this hole could be closed by a shovel-full of ashes and cinder. Beside these simple alterations the furnace-doors were fitted with perforated flash-plates, through which the air was allowed to pass into the furnace, in front of the fire, but above the grate. After the alteration, another series of experiments was tried with the steamer, and with the most signal success. The results were published in the Transactions of the North of England Institute of Mining Engineers, and accom-

* Transactions North of England Institute of Mining Engineers, vol. xviii, pp. 37–38.

pany a short paper by Mr. Bunning, a portion of which will subsequently be quoted. As it will be impossible to reprint in full, the tabulated results of these trials, it will be necessary to explain the method adopted (and now, I believe, agreed to as the standard by the Imperial Government), for estimating the exact amount of smoke produced by a given coal, consumed in the furnaces of any particular steamer. It is this:—Let the smoke issuing from the funnel of a steamer be noted every minute for an hour, upon a blank table, subdivided into minute-columns, similar to the table published with the Acadia coal-trial on the steamer "St. Lawrence" (Trial No. 2, of this Report). Let the figure 1, placed in a minute-space, indicate that the very faintest possible smoke, a mere indication of light-coloured gas was visible; 2, that this was increased, and so on to 6, indicating the densest black smoke. Having obtained these *smoke-marks* for an hour, the addition of them gives the *smoke-equivalent* for that time. This understood, the extract from Mr. Bunning's paper above referred to, will become intelligible to the reader. After referring to the tabulated record showing the smoke-marks for every minute during his experiments, he states:— **Rule for estimating smoke.**

"It will be seen that before the alteration, this smoke-equivalent averaged 107.9 over 25 experiments; that frequently, and for several consecutive minutes, dense black smoke was issuing from the chimney, and that there was rarely any actual cessation from smoke; while after the alteration no smoke of greater intensity than 2, was ever visible, and this only nine times in eighteen hours, for a minute each time; and that during the same eighteen hours the average smoke-equivalent was 7.7, each mark so rarely exceeded 1. This indicates that the very faintest possible smoke was visible only for 7.7 minutes in each hour, no smoke whatever being visible for the other 52.3 minutes. It would be vain to look for, nor indeed can any better results be found, even when the best of the so-called smokeless coals are burnt; for all practical purposes, therefore, good Hartley coal, as consumed in the *Weardale*, may be considered as smokeless as any other known coal. The plate* shows the alteration made to the fire-bars and bridge; the former were reduced from 5 feet to 3 feet 6 inches. The doors were not changed, and those shewn are those used by the Admiralty, admitting air at the bottom.† **Experiments on the Str. "Weardale."**

"The secret of burning the North Country steam-coal, and in fact all other good steam-coal, is to put it on as large as possible, as thick as possible, and to have as great a draft as possible, so as to burn off as large an amount per square foot of grate-surface as possible."‡ **Rule for burning North Country steam-coal.**

* Published with Mr. Bunning's paper.

† That is, the bottom of the door; the air passing into the fire through a perforated flash-plate.

‡ "*On Experiments on the Weardale.*" Trans. N.E. Inst. Mining Engineers, vol. xviii., pp. 105 et seq.

Farther trials and alterations.

Since these trials, which were carried out in the winter of 1868-9, farther experiments have been made by Mr. Bunning on the Weardale, and some slight alterations made, among which may be mentioned the placing of a door at the hole piercing the plate between the ash-pan and air-plate flue, which being moved by a bar extending to the front of the furnace, permits the admission of air, *at will*, behind the fire. Under date of 14th April, 1870, Mr. Bunning (to whom I am indebted for much information on this subject, which I would here gratefully acknowledge, writes me :—

Success.

" We consider the Weardale, now perfect ; she makes absolutely no smoke, and keeps her steam well."

A proper discussion of the rationale of these experiments, and of their importance to our coal-trade, must be postponed to some future occasion. Much more might be said in favour of the use of steam-coals of the class under consideration, and it can be clearly proved, that, if properly burnt, they are at least as economical, as smokeless, and as easily stoked as any other class of coals.

Use of Newcastle coal in the Navy.

The experiments above quoted, in connection with Government trials made at Devonport, already mentioned, have produced a material change of opinion with regard to Newcastle coal, and it has now taken a position second to none, among coals for the Navy, where it is chiefly used in admixture with Welsh coal, and the testimony of the very highest authority, is that a very large saving has already been effected by its use.

Necessity for steam and smoke-trials of our coals.

It is hoped that enough has already been said to call the attention of our coal-owners and consumers to the urgent necessity of practical trials of a similar character to those above mentioned. Such experiments could be carried out at a very trifling cost, on any steamers, without interfering with their regular voyages ; and though the great results of the North Country experiments might not be obtained, still, a great addition would be made to our knowledge of the coals, and that a very material improvement in the matter of steam and smoke would be made, cannot be doubted.

I shall close these remarks, which have already exceeded the length originally assigned to them, by an extract from a circular of the Coal Trade Association of Newcastle-on-Tyne, just received from Mr. Bunning. It is of interest as showing the results of the very latest trials.

RESULT OF EXPERIMENTS AT PORTSMOUTH, 1869-70.

Experiments at Portsmouth 1869-70.

" A very comprehensive series of experimental trials have been carried out during the past twelve months on board Her Majesty's steamers "Urgent" and "Lucifer," at Portsmouth, with Welsh and North-

Country coal mixed, and burnt in two forms of furnace, for the purpose of ascertaining the best proportions in mixed coal, and form of furnace for the consumption of smoke. The trials have been carried out under the direction of Captain E. Rice, A.D.C. to the Queen, commanding the Steam Reserve at Portsmouth, and the superintendence of Mr. G. Murdock, Chief Inspector of Machinery to the Reserve; and the results are considered to be so important, that orders have been issued from the Admiralty for the furnaces in the boiler-rooms of her Majesty's ships to be altered according to the plan finally adopted in the trials as the best for the consumption of smoke. When the comparative trials between the ordinary and the new form of furnace commenced, the proportions of the mixed coal burnt were one-third North-Country and two-thirds Welsh; but in all the later trials the coals have been burnt in equal proportions, and under these latter conditions less smoke has been emitted from the smoke-consuming furnace funnel than has been emitted from the funnel over the ordinary form of furnace, when the latter was burning the very best description of Welsh coal. The last three trials made on board the "Urgent" afford conclusive evidence of the success of the new form of furnace over the old. In the trial made on the 27th ult., both sets of furnaces were used, the coal burnt being Ferndale and Cowpen's Hartley, in equal proportions. The report of this trial gave the following results:—

Change of furnaces in the navy.

H. M. S. "Urgent."

	New Furnace.	Old Furnace.
Smoke	1.55	4.55
Coal burnt per hour	2,940 lbs.	3,294 lbs.
Producing		
Ash	23.14	32.75
Soot	2.82	5.16
Clinker	35.08	25.00

The last two trials made were on the 2nd and 11th insts., the new furnaces only being used on the former, and the old furnaces only on the latter trial, the coal burnt in each instance being equal quantities of Powell's Duffryn and Cowpen Hartley, with the following results:—

	New Furnace.	Old Furnace.
Coal burnt per hour	2,912	3,397.3
Producing		
Ash	17.73	24.34
Soot	1.94	4.06
Clinker	31.0	40.6

In these two trials, the new furnaces exhibited a saving upon the old, of .28 per cent. in fuel, an increase of 7.56 per cent. in horse-power, and positive gain in the consumption of smoke, of 21.84 per cent."

PRACTICAL TRIALS IN GAS MAKING.

Requisites of a gas-coal.

The most important requisites of a gas coal are :—1st. That it contains a large amount of volatile combustible matter (gas);—2d. That this volatile matter be of good illuminating power, and as free as possible from sulphur, and—3d. That the coke furnished by the carbonization of the coal be bulky, and at the same time firm, (*i. e.* not inclined to be granular.)

The importance of the first requisite, will be evident to all. The percentage of volatile matter in true coals usually employed in gas-making, is from 25 to 40 per cent., and in cannels it rises to 60 or 70 per cent.

The true bituminous coals of this district which are now being worked, average, according to the latest analyses, as given in the first Section of this Report, about 28 or 29 per cent. of volatile matter ; the content of the hardest being 20.46 per cent., and of the softest being 38.84 per cent.

Gas-content.

The oil-coals, oil shales, and a single cannel range higher in gas-content, the stellarite reaching 68.38 per cent., and Lawson's cannel 41.18 per cent., which last figure is not, however, a high percentage of volatile matter for a cannel. That the percentage of volatile matter, given by analysis in the small way, is not always a true index of the value of a gas-coal, will be seen by a reference to the analyses of the Foord-pit coal, which stands nearly at the head of the list of Pictou (true) coals, as a gas-producer. The percentage of volatile matter appears rather low in this case, in fact so much below what would be expected from so good a gas-coal, that I am inclined to suspect that the samples analysed in the small way, were not fair averages of the produce of this colliery.

Quality of gas.

That the gas produced from the coal be of good illuminating power, is most important, will also be seen, though from the fact that the standard of illuminating power can easily be raised by the addition of a few per cent. of some rich cannel, or substance of the character of the stellarite, many coals, which produce gas of a low standard, but in large quantity, (if they coke well,) are often used as gas-coals. The stellarite has been used to raise the standard of illuminating power of gas from other coals ; as are also, torbanite, albertite, cannels, and many oil shales. To instance a case of this kind, I may state that Mr. Thompson, of the Pictou Gas-works informs me that when using a coal giving *per se* 15-candle gas, he adds 10 per cent. of Leshmahagow cannel, in order to raise the gas to the standard of 18 candles.*

* The standard candle in testing gases, is of spermaceti, burning at the rate of 12[illegible] grains to the hour. To compare the illuminating powers of gases, the light given by a standard burner burning five (5) cubic feet per hour of the gas under examination, is compared with the light of one of these standard candles, the result giving the *candle*

The majority of the coals of the Pictou region furnish an excellent coke in the gas-retorts, if properly carbonised, as will be abundantly proven by the statements to be given below from some of the first gas-chemists of this continent. Statements have recently been published to the effect that coke from these coals is worthless. In a single case this may be warranted; in the majority of cases it is not, as from a number of the coals I have seen most excellent coke made in the gas-retorts of the Pictou works. It is true that if the heat is not properly applied, the coke cannot be properly formed, and a few of these coals will never be successfully coked, but the testimony of our first gas-chemists, such as Buist of Halifax, and the engineer of the Boston Gas works, who have used many thousand tons of the coals, is that some of them furnish good merchantable coke. Coke.

The greater number of the coals of this district will, I believe, compare favourably with those of any district of the world in regard to sulphur. A number of analyses in the first section show the sulphur-content of the different coals, which in most cases is considerably below 1.00 per cent. These determinations of sulphur may be compared with the following table, giving averages of determinations of sulphur in a large number of the coals of Great Britain, from the analyses given in the reports of the British Admiralty Trials: — Sulphur.

						Per cent.
Average of	37	samples from	Wales.	gave	of sulphur....	1.42
"	17	"	Newcastle,		"	.94
"	28	"	Lancashire,		"	1.42
"	8	"	Scotland,		"	1.45
"	8	"	Derbyshire.		"	1.01

Further statements concerning the small amount of sulphur in Pictou coals, will be found in the extracts of letters from Messrs. Buist and Greenough, given below.

GAS TRIALS AT THE PICTOU GAS-WORKS.

Mr. Alex. Thompson, of the Pictou Gas-works, has used all the coals which have been worked to any considerable extent in this region, and he has been kind enough to supply me with notes of his experience, from which the following tabulation has been compiled. Gas trials at Pictou.

power of the gas. Thus if we suppose a gas burnt in a five-foot burner to give fifteen (15) times the amount of light furnished by one standard candle, the gas is said to have 15-candle power or to be 15-candle gas. The standard of gas in our large cities ranges from 13 to 18-candle power.

PRODUCTION OF GAS, AND QUALITY OF GAS AND COKE, FROM VARIOUS COALS AT THE PICTOU GAS-WORKS.

(FROM NOTES OF MR. ALEX. THOMPSON, MANAGER.)

Results of trials at Pictou.

Company shipped by, and name of mine.	Cubic feet of gas (per ton of 2240 lbs.)	Illuminating power (candles.)	Bushels of coke per ton.	Character of coke.	Remarks.
GENERAL MINING ASSOCIATION.					
Foord Pits, (1869 shipments.)	8,000	18	35	Good.	
Albion (Old) Mines.........	7,700	16	34	"	
Forster Pit..................	6,000	13	32	Not good.	Coke unsaleable.
Dalhousie Pit...............	7,500	15	32	Good.	
Cage Pit, (old shipments)....	7,800	17	34	Good.	
ACADIA COAL COMPANY.					
McGregor workings........	7,600	14	34	Fair.	Coke firm, but sulphurous.
Fraser Mine, stellar coal....	11,000	36	......	....	Coke worthless.
" oil-shale......	8,000	30	......	....	" "
Acadia Colliery, west slope.	7,000	13	32	Not good.	Coke granular.
INTERCOLONIAL COAL COMPANY.					
Drummond Colliery........	7,700	15	34	Good.	
NOVA SCOTIA COAL COMPANY.					
Nova Scotia slope...........	7,000	14	32	Fair.	Coke saleable.
MONTREAL AND PICTOU COAL CO.					
Montreal and Pictou pit....	6,000	13½	28	Not good.	
PICTOU COAL MINING COMPANY.					
Marsh Colliery..............	6,000	14	28	"	

Of the coals named in the above list, that from the Foord pits appears to give the best result in gas-making, from its large gas-content, the high illuminating power of the gas, and the superior coke produced in its carbonization.

Value of the different coals.

The Drummond coal, and the coals of the Old mines, Dalhousie and Cage pits, appear to stand next, the value of the other coals for gas purposes falling slightly below these. The stellarite and oil-shale of the Acadia mines are most valuable for mixing with the coals, to increase their illuminating power, but would not be of great value if used alone, for two reasons: because their cokes are worthless, (being merely a cinder, with but a few per cent. of fixed carbon, and therefore useless in heating the retorts); and because the gases produced in carbonizing them are too carbonaceous for use with ordinary burners. Good coke is not only valuable to the gas-manufacturer as a merchantable product, but also is used for heating the retorts, and therefore cannels, and substances like torbanite, stellarite, and albertite, though producing a large amount of highly carburetted gas, are seldom used in gas-manufacture, except in mixture with coals furnishing a good coke.

I shall now proceed to give such facts as it has been possible to procure concerning the value of the different coals of this district in gas-manufac-

ture, some of which facts have already been published, while others have been obtained by correspondence, and in one case a special trial has been made at the Pictou Gas-Works.

COALS OF THE ALBION MINES.

The following extracts are from letters by Mr. George Buist, Manager and Chemist of the Halifax Gas Company, and Mr. W. W. Greenough, Manager of the Boston (Mass.) Gas Company, in answer to letters from myself, soliciting information for this Report. The companies represented by these gentlemen, have been for years large consumers of the Albion Mines coal. Albion-Mines coal.

LETTER OF MR. GEORGE BUIST.

(*Copy.*)

GAS OFFICE, HALIFAX, N.S., Feb. 24th, 1870.

Edward Hartley, Esq.,

DEAR SIR,—

I beg to acknowledge receipt of yours of 8th instant, making enquiries regarding Pictou coal.

I think the following statement may be taken as giving the correct quantities of the gas, coke and tar produced from one (1) ton of 2,240 lbs. Mr. Buist's letter.

The quantity of gas will average about..............	7,300 cubic feet.
Illuminating power, about	15½ to 16 candles.
Weight of coke, about............................	1,450 lbs.
Quantity of coal-tar, about........................	9½ to 10 gallons.

The sulphur in the Pictou coal is very much less than in any of the other Nova Scotia coals. The quality of the coke is very good indeed. * * * *

I remain,

Yours truly,

(*Signed*,) GEORGE BUIST.

LETTER OF MR. W. W. GREENOUGH.

(*Copy.*)

OFFICE OF BOSTON GAS LIGHT COMPANY,
No. 20 West Street, Boston, Feb. 7th, 1870.

Edward Hartley, Esq.,

DEAR SIR,—

Your letter of inquiry of the 4th instant reached me * * * * * * * *

We use the caking coals of Pictou and Cape Breton, in combination with richer coals. The proportions of these combinations are based upon experimental trials of each coal separately. Mr. Greenough's letter.

The best results in gas-making with the Pictou coals, are obtained by working the retorts at a cherry-red heat. One then gets from each ton of 2240 lbs., 7280 feet of gas—of *strong* 15-candle illuminating power, with a yield of 1325 lbs. of coke of fair quality. Higher heats will give more gas of an inferior grade, and with a diminished value of coke. This coal contains but a small proportion of sulphur compounds, is easily purified, and may be safely stored without danger from spontaneous combustion.*

* * * * * * * * * *

Yours truly,

(*Signed*,) W. W. GREENOUGH.

* The rest of this letter refers to Cape Breton coals, and need not be quoted here.

I would take this opportunity to thank Messrs. Buist and Greenough for the above facts, and for other valuable information they have kindly given me.

The statements in the following memorandum, sent me by Mr. Jas. Hudson, Chief Manager of the General Mining Association, are partially a repetition of the above facts:—

"Extract from letter of W. W. Greenough, Esq., Treasurer of Boston Gas Light Company, December, 1869.

"'We have made no recent analysis of gas made from Pictou coal, but the experience of several years working shews a uniform result:—with cherry-red heats, of 3¾ cubic feet to the pound, of 15-candle gas; with a condensation by bromine of 6.75; a specific gravity of 4.75; and the *smallest per centage of sulphuretted compounds of any coal called caking.* Coke fair. Higher heats will give more gas, at the expense of the illuminating power of the gas, and the quality of the coke.'"

McGREGOR COAL (ACADIA MINES).

McGregor coal. The following statements are from the published report of Mr. Jesse Hoyt, Manager of the Acadia Coal Company, 1866:—

"On the 9th. of February, 1865, one ton of this coal, a mixture of both benches, was tested in the works of the Manhattan Gas Company, New York, with the following results:—

Trial at New York, U. S. "'One ton of 2,240 lbs. yielded 9,500 feet of 13.03-candle gas, and 41 bushels of coke, weighing 1,640 lbs. The coke is good; it contains rather much ash, and makes some clinker, but it burns well, keeping up a good strong fire. The coal seems to deserve a trial on a larger scale, as it is very readily carbonized, yielding a good volume of gas and coke.'"

Analysis of the coal.

Volatile matter	32.0
Fixed carbon	59.3
Ash	8.7
	100.0

"A subsequent trial was made by the same company, but the result was not so favourable, as will appear by the following report:—

Second trial. "'One ton of 2,240 lbs. yielded 9,500 feet of 13.34-candle gas, and 38 bushels of coke, weighing 1,744 lbs. The coke is poor; it clinkers badly, and does not keep up the fire under the retorts. It requires 4 bushels of lime to purify a ton.'"

Analysis of the coal.

Volatile matter	26.8
Fixed carbon	57.9
Ash	15.3
	100.0

Mr. Hoyt remarks that he believes the unfavourable result in the latter trial, to have been caused wholly by the admixture with the coal, of foreign matter from the *shale-band* or fire-clay parting, between the first and second benches of the McGregor seam.*

DRUMMOND COAL.

Drummond coal.

Through the kindness of Mr. Dunn, Manager of the Intercolonial Coal Company, I procured a special gas-trial of three coals, from the three upper divisions of the Acadia seam, as worked at the Drummond colliery.

Special gas-trials.

This trial was made under the superintendence of Mr. Alexander Thompson, Engineer and Manager of the Pictou Gas Company, at their works. The samples were of two barrels each, and believed to be fair averages of the different benches. They were marked and numbered as follows:—

Sample No. 1,—Top of seam, (2 feet 6 inches thick) left in the workings.
" No. 2,—From the fireclay *holing*, 2 feet up to the smooth parting. (Fall coal.)
" No. 3,—First bench. Below the *holing*, and 4 feet thick.

The numbers of these samples correspond to the numbers of the divisions and analyses of this seam at the Drummond colliery, in Section I. of this Report.

The following is a copy of Mr. Thompson's Report:—

(*Copy*.)

Mr. Thompson's Report.

GAS WORKS, PICTOU, N.S.
December 4th, 1869.

Edward Hartley, Esq.,
Geological Survey,

SIR,—

At your request I have carefully examined the contents of six (6) barrels of coal from the Drummond colliery, marked respectively Nos., 1, 2, and 3, with the following results:—

No. 1,—Yields at the rate of			7,000	cubic feet of gas and			32	bushels of coke to the ton.			
No. 2,—	"	"	"	7,500	"	"	"	32	"	"	"
No. 3,—	"	"	"	8,500	"	"	"	36	"	"	"

The gas has an illuminating power of 15 candles. The volatile combustible matter is such in amount and character as to promise well in gas-making. The coke is firm and of good quality, well adapted for heating the retorts in gas-making, and can thus take the place of coal for that purpose.

I am, Sir,
Your obedient servant,
(*Signed*,) ALEX. THOMPSON,
Engineer and Manager.

Beside their use as steam and gas-producers, several Pictou coals are sold extensively for various other purposes, among which may be mentioned, re-heating iron, blacksmithing and domestic purposes. The cokes of one

* See Geological Report, Section 4, pp. 67-et seq., beds 71—73, See also page 96 of the same Report, and the first Section of this Report.

or two of the coals have also been, to a certain extent, successfully used i iron-smelting and founding. I am not at present able to furnish any exac data concerning the success with which they are used in rolling-mills etc and no iron-smelting is at present carried on at any point near the Picto district; but I am aware that in the Eastern United States, the coals ar used in various forges and rolling, mills, with very good success, and I ar assured by Mr. E. A. Jones, Manager of the Acadian Iron Works at Lor donderry, Nova Scotia, that he has used Albion Mines coke in iron-smelting and finds it better suited to this work than any other Provincial coal he ha used.

For domestic purposes these coals are well and favourably known ; they light easily in the grate and burn well and long with very little attention except in the few cases where the content of ash is very large.

III.

IRON ORES OF PICTOU COUNTY.

Localities of iron ore.

A number of localities are known in the vicinity of the Pictou coal-field where ores of iron have been found. None of these have ever beer developed to any extent; and the few trial-pits upon the deposits, afforc very unsatisfactory evidence as to their size and value. The ores o iron which have been recognized in this vicinity are ; specular iron, limonite or brown hematite, and spathose ores (crystalline carbonates of iron) besides the clay-ironstone, or argillaceous carbonate of iron of the coa measures.

In the following paragraphs, mention is made of those localities only which I have personally examined, though a large number of others exist, of greater or less value. My field-work in this district was confined to the productive coal-field, except in the few cases where examinations beyond its boundaries were made at special request. The samples analysed, where no statements to the contrary are made, were taken by myself from the deposits, and are believed to be the averages of the ores. The analyses have been made in the laboratory of this Survey, by Mr. Broome.

SPECULAR IRON.

Specular iron

Several deposits of specular iron were examined ; these all occurred in a range of metamorphic rocks lying ten or twelve miles to the south of the coal field. The ore of the variety known as micaceous iron ore, was noted at Battery Hill, near Glengarry station, and proceeding east from this point at a number of localities near the line of the Provincial Railway, the range of rocks including it finally crossing this railway and the East River of Pictou, several miles above Springville. Of the age of this for-

mation, I cannot speak with certainty, but it is probably Upper Silurian; the rocks consist of quartzites, of light and dark green, purplish, brown and black colours, and slates highly altered, generally of a black colour and giving a white streak. The quartzites are sometimes coarsely granular, but as a rule, compact and fine grained. This formation appears quite distinct in lithological character from the series which has been described in the Reports of Sir William E. Logan and myself, as occuring near the Pictou coal field, at McLellan's and McGregor's Mountains, and at Waters' Hill, and which are believed by Dr. Dawson to be of Devonian age.

Age of including rocks.

I have made no attempt to obtain fossils in these rocks, nor has any bed been observed likely to contain them, at the few localities examined; but it seems probable that the fossiliferous beds mentioned by Dr. Dawson in his Acadian Geology, (pages 568-570), as occurring near Springville, are included in this series. These beds, from which a large number of fossils have been collected by Mr. D. Frazer of Springville, are of undoubted Upper Silurian age.

Fossiliferous beds.

The specular iron appears to exist in true fissure-veins, but of no considerable size, at any locality which I have seen. In many cases the rocks holding it appear to be much shattered, and the specular iron, with a compact granular quartz as a veinstone, appears to fill the fissures, which are often confined to a particular bed of rock, and sometimes so numerous that the entire bed contains a large per centage of the ore, and may be considered as a single deposit. The most important deposit of this class which I have observed, occurs on the west side of the East Branch of the East River about three and a-half miles above Springville, on the lots of John McDonald and Archibald Thompson. Here the specular iron seems to exist over a considerable area, some portions being quite pure, but as the deposit is opened by two shallow pits only, it is impossible to state its size, or exact relations to the including rocks. The minor veins are often of several inches in thickness, and are included in a light greenish-drab granular quartzite, which they traverse in the most irregular manner. A sample of this ore was taken by me, which appeared to represent an average of what might be mined, provided all the larger lumps of quartzite taken out in mining were rejected. This sample gave on analysis:—

Character of the deposits.

Analysis.

Sesquioxide of iron	65.14
Silica	32.50
Hygroscopic moisture	.91
	98.50
Total amount of metallic iron ... per cent.	45.60
Specific gravity	4.607

From the amount of silica present this ore would require a considerable amount of limestone as a flux, or it could be advantageously smelted

Gozzans from these deposits.

with a calcareous sparry iron ore like that used for mixture with hema tites at the Acadian Iron Works at Londonderry. The locality i well worth a careful exploration, as the deposit seems continuous, and of considerable width. It is, in common with many other of these deposit easily traced upon the ground, from the bright rust colour of the soil, an the presence on the surface of a large amount of partially decomposed ore or *gozzan*, which is easily recognised. The appearance of this substanc is very deceptive to the inexperienced eye, and I have frequently ha specimens of it brought to me, by parties who, from its uniform rust-re appearance, had been led to imagine it a very rich iron ore. Attentio to its low specific gravity will often show how small an amount of iron i contains. The following is the result of a partial analysis of a sample c one of the best of these *gozzans* which I have seen. It was sent me fro Rockland fulling-mills, on Middle River, by Mr. Robert Frazer, and i appearance was quite equal to some of the pure ochrey *gozzans* which ar found in some other localities, but analysis shows it to be merely porous mass of granular quartzite, deeply stained with iron-oxyd.

Analysis of a *gozzan*.

Sesquioxide of iron		25.48
Silica		62.61
Hygroscopic moisture		.81
Volatile at a red heat		4.43
		93.33
Amount of metallic iron	per cent.	17.84

The remaining constituents were lime, magnesia and manganese, whicl were not determined.

LIMONITE OR BROWN HEMATITE.

Limonite.

Numerous boulders of a very pure variety of limonite, have been founc in the vicinity of Springville, on the East River, bnt so far as I ca learn, the ore had not been found in place until Oct. 15th, 1868 when a bed was discovered, on James Frazer's land, about $1\frac{3}{4}$ mile above Springville, (on the east side of the East Branch of the Eas River), by Mr. A. P. Ross, of Pictou, and myself, while visiting th locality. The only exploration we were enabled to make, was a shallov pit, sunk in a few hours by one man, but this was sufficient to expose mass eight feet in thickness, of a pure limonite of the mammillary, stalactitic and fibrous varities. It was overlaid by a close grained altered sandston or granular quartzite of a light greenish-gray colour, and appeared to b conformable to the stratification. The bottom of the bed was not exposed it was hidden by a high drift bank ; neither was the deposit traced for an

distance on the strike. Should it prove to be a persistent bed, it would be a most valuable deposit, as the ore is one of the purest known. No substance save the pure mineral was discovered in the bed, the roof appearing well defined.

The following analysis is of an average specimen taken by myself. It will be observed that the silicious residue does not equal half of one per cent :—

Analysis.

Sesquioxide of iron		84.94
Combined water		15.43
Hygroscopic moisture		.92
Silica, (insoluble residue)		.41
		101.70
Amount of metallic iron	per cent.	59.46

The rocks including this deposit appeared to belong to the same series as those further south, holding the specular iron deposits above described.

SPATHOSE ORES.

Spathose ore near Merigomish.

On the land of Neil McLaurin, about one and three-quarter miles south-west of Sutherland's bridge on Sutherland's river, a peculiar deposit of iron ore occurs, included in Indian-red and greenish-drab sandstones, apparently of the Millstone-Grit series. This ore, which I designate as spathose iron ore, appears to be a mixture of spathic iron, or crystalline carbonate of iron, and red hæmatite, or anhydrous peroxyd of iron, with but little impurity. The ore is seen in place, on the south bank of Sutherland's brook, where it is exposed by a number of costeening-pits, and it has also been traced for about 100 feet west of the point where it was first opened, the strike appearing to be very nearly E. and W., and the attitude nearly vertical.

Size of deposit.

Whether this deposit should be considered a bed or a vein, is still a matter of uncertainty, but it appears to be comformable with the stratification. Its thickness, where exposed, varies from eleven to fourteen feet. Several attempts had been made to trace it farther westward at the time of my visit, but the pits sunk had failed to penetrate the drift. That this deposit, if found to be persistent, would be of considerable value, may be judged from the following analyses. No. 1 is of a specimen from the outcrop, on Sutherland's Brook, and No. 2, from a costeening pit, about 75 feet farther westward.

	I.	II.
Sesquioxide of iron	16.98	20.52
Carbonate of iron	65.61	57.40
Carbonate of manganese	7.98	8.29
Carbonate of lime	2.67	4.02
Carbonate of magnesia	3.23	5 66
Silica	3.76	2.38
Hygroscopic moisture	.76	1.43
Sulphur	none.	undet.
Phosphorus	.013	"
Organic matter	trace.	none.
	101.003	99.70
Amount of metallic iron	43.56	42.07

Dr. T. Sterry Hunt has kindly furnished me with the following note on these specimens:—

Dr. Hunt's opinion on the Spathose ore.

"The iron ores from Merigomish, Nova Scotia, consist of an admixture of red hæmatite and sparry carbonate of iron, with considerable manganese and but little lime, magnesia and silicious matter, and they appear, moreover, from the results of their analysis, to be remarkably free from sulphur and phosphorus. Their composition is such as to make them very readily reducible with a small amount of fuel in the blast furnace, while the presence of manganese, and their comparative freedom from sulphur and phosphorus, should make them peculiarly well fitted for the production of steel, either by puddling or by cementation."

CLAY-IRONSTONE.

Clay-ironstone.

A large number of bands of clay-ironstone were noted during my examination of the Pictou coal-field, but none of a size generally considered workable. Some thirty years ago, however, a cross-cut was driven by the General Mining Association upon the measures underlying the Main seam at the Albion mines, and several beds of ironstone were intersected. No reliable record remains of their size and quality, and the attempts which were then made to smelt them are known to have failed, but whether from mismanagement, or from the poor quality of the ore, is not certain.

At the present day these ores are better understood, and it would seem probable that some of these beds could be worked in connection with one of the seams, and smelted with some of the richer ores of the upper East River.

E. H.

Montreal, P.Q., 22nd June, 1870.

NOTES

ON

COAL FROM THE SPRINGHILL COAL-FIELD,

COUNTY CUMBERLAND, NOVA SCOTIA,

BY

EDWARD HARTLEY, F.G.S.,

MINING ENGINEER TO THE GEOLOGICAL SURVEY.

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In the month of June, 1869, I had the honour to present a Report to Sir [W]illiam E. Logan, F.R.S., then Director of this Survey, giving the result [of] a special examination of a box of coal samples, from the Main seam of [th]e Springhill coal-field, County Cumberland, Nova Scotia. The facts [co]ntained in that Report are now included in the following paper, together [wi]th a few notes of interest concerning this important coal-field, which [I] have been able to obtain through the kindness of the Honourable Dr. [Ch]as. Tupper, C.B., and M.P., for County Cumberland.

EXAMINATION OF MAIN SEAM COAL.

The samples of coal examined were taken from the Main seam of the [Sp]ringhill coal-field, and were obtained at the "Black Mine." The [sa]mple box contained about sixty pounds of coal (round and slack). Springhill Main seam.

An examination of the external character of this coal shows it to be a [bit]uminous coal of a moderately compact texture, and not inclined to fall [to] pieces, or *slack*. Its colour is a bright brownish-black, brilliant, except [on] the faces of the *partings*, which show a few patches of mineral charcoal. [Bu]t a small proportion of the sample shows a shaly lamination, or ten[de]ncy to break with the planes of deposition. It has a tendency rather to [br]eak with the cleat and cleavage-planes, which are inclined to the [de]position-planes at angles varying from 65° to 75°, and occasionally [..]°, giving irregular surfaces, known technically as *crystalline* faces.

Four samples were taken for analysis:—I and II were two

averages of the whole box;—III was a picked sample of the best (mc compact) coal, and IV. was a specimen of the coal showing a sha texture. The results of proximate analysis in the laboratory were follows :—

Analyses.

	HARTLEY. I.	II.	III.	IV.
Hygroscopic moisture	1.21	.98	.58	1.28
Volatile combustible matter	33.08	35.52	33.27	35.66
Fixed carbon	61.49	59.42	63.85	58·53
Ash, (perfectly white)	4.22	4.08	2.30	4.53
	100.00	100.00	100.00	100.00
Coke	65.71	63.50	66.15	63.06

Sample I was carbonized by a slow and careful application of heat; b in treating II the heat was suddenly applied, and the carbonization effect as rapidly as possible. Analysis I thus shows the smallest amount volatile matter obtainable from the coal, and II the largest. Determinatio were made of the sulphur in sample I, with the following results:—

Sulphur content.

	Per cent.
Total amount of sulphur in coal	0.225
Amount of sulphur in ash, (as gypsum)	0.108
" " " as iron pyrites, by difference	0.117

The analyses show this coal to belong to the class known as high bituminous, or *fat* caking coals, in character very similar to those of tl North of England, known as North Country, or Newcastle-Hartley coals

Value for gas-making.

The high rate of volatile to fixed combustible matter should render tl coal, in common with the Newcastle coals which it resembles, an admirab gas-coal, while in the amount of sulphur it falls much below the avera of Newcastle coals (which contain about nine-tenths of one per cent, determined by the Admiralty steam-coal trials); therefore the gas obtaine from it shouldbe very easily purified.

For iron-smelting.

The coke of this coal appears in every way well adapted for iron-smeltin as it is firm, and rather compact, and in content of ash and sulphur w compare most favourably with that from any coal of the Provinces. This co is much more easily formed and of a better quality than from the great number of Provincial coals. As the amount of ash is a most important poi

Ash.

in iron-smelting, it may be well to give the following data concerning the a content of other coals for comparison. They are taken from Professor W R. Johnson's Coal Trade of British America, (page 126) in his compariso of the Reports of the British and American Commissions, on coal trials :–

		Per cent.
Average of ash in 30 British coals	laboratory analysis	5.76
" " " 35 American coals	" "	7.76

Showing in favour of average Springhill coal as compared with British coals, a balance of 1.61 per cent, and of 3·61 per cent., as compared with American, in ash-content. For comparison with coals of the other districts of Nova Scotia, it may be stated that Pictou coals average from 7 to 9 per cent. of ash; Sidney (so far as published analyses show), from 5 to 7 per cent., and Cumberland (Joggins) coal from 5 to 6 per cent. Comparison.

With regard to the use of this coal as a steam-producer, I would refer the reader to the article "Remarks on the trials of steam-coals," in my recent Report on the Coals and Iron ores of Pictou County. (This vol. pp. 426 to 431) in which it is shown that coals of this class are now burnt with an evaporative power equal to that of the Welsh semi-anthracites, or free-burning steam-coals. The remarks there made, calling attention to the importance of these trials to the Pictou coal trade, apply with greater force to the coal under consideration than to Pictou coals, on account of the nearer approach in character of the Springhill coal to those of Newcastle. At the date of my original Report on the Springhill Main-seam coal, I was not possessed of any result of ultimate analysis, but attention was then called to the resemblance of the coals in proximate constituents, and the following analyses given: A—is an analysis of Hartley coal from Newcastle-on-Tyne. B—an average of a number of analyses of Newcastle coals (both A and B from the appendix to Richardson's, Knapp's Technology); and C—an average of analyses I and II of this paper; being of the Black Mine samples. Value as steam-coal. Comparison with coals of Newcastle.

	A.	B.	C.
Volatile matter, water included	35.50	37.60	35.39
Fixed carbon	60.50	57.00	60.46
Ash	4.00	5.40	4.15
	100.000	100.00	100.00

Since the circulation (in manuscript,) of the original Report, I have received an ultimate analysis of this coal, by Dr. John Percy, F.R.S., of the Royal School of Mines. This analysis was made by Dr. Percy some years since, for parties interested in the Springhill coal-field, the specimen analysed being a sample from the outcrop, of which the following proximate analysis is given:— Analysis by Dr. Percy.

	PERCY.
Coke	64.94
Volatile matter	31.08
Water	3.98
	100.00

The small amount of volatile matter, and the large amount of water present in this sample, would lead me to believe that its quality was not equal to that of the coal examined by me.

The following table gives Dr. Percy's analysis, and also analyses of the Newcastle coals used in the late British experiments on North Country coals, as noticed in the Report on Pictou coals, already referred to, the analyses of Newcastle coals being on the authority of the Reports of the British Commissioners in the Admiralty steam-coal trials. In these analyses no account of the moisture in the coals appears, and it is to be presumed that the samples of coal analysed were either dried before being treated, or that the amount of moisture was exceedingly small. Therefore, I have added a re-calculation of Dr. Percy's analysis, based on the supposition that the sample of Springhill coal was dried, (or disregarding water.) Analysis 7, of the following table is by Dr. Percy, of the coal from Springhill, including water, and 8 is the calculation from this analysis of the ultimate constituents of the dry coal.

Table of analyses.

NAMES OF COALS.	Carbon.	Hydrogen.	Oxygen and Nitrogen.	Sulphur.	Ash.	Coke.
NEWCASTLE COALS.						
1. West Hartley Main	81.85	5.29	9.22	1.13	2.51	59.20
2. Hastings Hartley	82.24	5.42	8.05	1.35	2.94	....
3. Davison's West Hartley	83.26	5.31	4.22	1.38	5.84	59.49
4. Original Hartley	81.18	5.56	8.75	1.44	3.07	58.22
5. Cowpen and Sidney's Hartley	82.20	5.10	9.65	0.71	2.33	58·59
6. Derwentwater Hartley	78.01	4.74	12.15	1.37	3.73	54.83
SPRINGHILL COAL.						
7. Main coal, (outcrop) including 3.98 p. c. of water	75.51	5.00	9.37	1.09	5.05	64.94
8. Main coal, (dry)	78.51	5.19	9.66	1.12	5.20	....

GENERAL REMARKS ON THE COAL-FIELD.

General remarks.

The Springhill coal-field is situated about twenty miles south-east of the Joggins shore, in County Cumberland, Nova Scotia. Whether it is to be considered a detached coal-field, or a portion of the great Cumberland coal-field of Nova Scotia, is still an open question, only to be decided by a careful geological survey. This region appears to warrant the most careful examination, from the fact that it is destined to become of the greatest importance to the Province, at no distant period. At present no active collieries of any extent exist in this coal-field, for want of communication with tide-water; but the completion of the Intercolonial Railway, (which will pass directly through some of the surveyed coal areas,) will effect communication not only with the Bay of Fundy, (at Amherst, about 22 miles distant), but with the Basin of Mines, Halifax, and many other points where the coal will be in demand; and no doubt a large amount

Intercolonial railway.

of the coal, or coke produced from it, will be consumed upon the railway. About thirty miles to the south of Springhill, the railway will pass through the property of the Acadian Iron Company, about two and one-half miles from the Acadian iron mines at Londonderry, thus connecting this important district with the coal-field. The Acadian mines are so well known, from many published reports and descriptions, that it seems unnecessary to give any description of them here, and in this connection it will suffice to say that the supply of iron ore of remarkably good quality thus brought in connection with a coal well adapted for smelting and puddling, seems, from all descriptions, to be practically almost inexhaustible. The main vein (on the authority of Messrs. Woodhouse and Jeffcock, Mining Engineers, of London,) has been traced for a distance of twelve miles from east to west, and it is stated that did the trade admit, numerous workings might be located thereon. The ore at the Acadian Iron works is at present smelted with charcoal, the iron produced being of the best quality, taking a rank in the English market, second only to the better brands of Swedish charcoal iron. Acadian Iron Works.

The Springhill district may be divided into two sections—North and South Springhill. The Black Mine, from which the coal examined was taken, is situate in the South Springhill section, or on the southern outcrop of a coal-measure synclinal, the axis of which is nearly in an east and west direction. Five coal seams have been discovered in this section, and their relations and thicknesses are stated to be as follows, in descending order:— Divisions of the coal-field.

Seam A—three feet in thickness.
" B—thirteen feet in thickness, lately discovered on the "McFarlane claim." Seams of South Springhill.
" C—*Main Seam;* eleven feet three inches in thickness, the coal of which has received especial attention in this paper.
" D—three feet in thickness.
" E—two " "

The Report of the Provincial Inspector of Mines, for 1869 (page 22), states that the coal of all these seams is of excellent quality.

MONTREAL, 28th June, 1870.

APPENDIX.

ON THE PLANTS OF THE MANITOULIN ISLANDS

BY

JOHN BELL, M.A., M.D.

The plants whose names are contained in the following list, I collected during the summer of 1866,* while with my brother on a geological exploration of some of the islands of the Manitoulin group. The list is a very incomplete one of the flora of the district examined, as the collection of plants was made entirely subordinate to the proper work of the expedition. I, however, seized the opportunities afforded at various stations, from Owen Sound northward, to make notes of the local flora, and collect specimens, in order to ascertain the range of many plants in that interesting region.

Most of the plants were collected on Cockburn, Drummond and St. Joseph Islands, the geological survey of which was the object of the expedition. Some of the smaller islands were also touched at, and a visit to Gore Bay, on the north side of Grand Manitoulin Island, enabled me to obtain some rare specimens from that point, and from the interior of the island to the south and south-east of it. While detained a few days at Owen Sound, previous to starting, I collected plants in different directions, and found several rare species of ferns growing luxuriantly and in abundance on or near the limestone escarpment to the south-west of the town. A number of specimens were also obtained at the Bruce Mines, and in the vicinity, on two different occasions.

The physical geography of the several islands mentioned above differs considerably, and with it the vegetation. St. Joseph Island is, for the greater part of its extent, somewhat elevated, consisting, apparently, of sand and gravel, covered over with a thin layer of vegetable mould. The land rises gradually from the lake shore towards the middle of the island. Nearly in its centre, however, there is a depression, the bottom of which is occupied by a small lake. On the dry gravelly soil of St. Joseph Island a very heavy growth of hard-wood forest was found, consisting of beech, hard maple, hemlock, bass-wood, black and yellow birch, with a few rather scraggy white pines; while on the lower ground they were almost replaced by black ash, cedar, balm-of-Gilead and aspen-poplar, balsam-fir, elm, mountain-ash, and many small and arborescent shrubs. The red elder was very conspicuous by its abundance and the profusion of its clusters of bright scarlet berries. From the circumstance that this island is immediately in the course of both the American and Canadian steamers and other vessels, large quantities of cord-wood are now cut and sold to them. In the future there is no doubt that the forests of this island will be of great value for fire-wood, if not for timber.

A traverse across the island, from Hilton town-plot, on the north side, to Richardson's, on the south, was made on the 25th July, so that the plants mentioned as having been found at these places, and in the interior of the island, were collected on that and the fol-

* See Report by Mr. Robert Bell, page 109.

lowing day. The plants from the Bruce Mines were obtained on the 24th July and 28th August. We visited the small island at the east end of St. Joseph on July 28th, and Hay Point, on the south side, on the 1st September.

Drummond Island, the next to the east of St. Joseph, by a northward curve in the international boundary line, is included in the territory of the United States. The level of this island is lower than that of the others, and the land is, in a large extent, flat and marshy, the trees being for the most part small balsams, tamaracks, and spruces. On the north side the island is more hilly than on the south, and on that side heavier forests are met with than on the south, the prevailing trees being hard maple, beech, basswood, iron-wood, balsam-fir, poplar and white cedar, with some white pine. In some places the flat limestone rocks come to the surface, and support only a sparse, stunted growth of firs, with patches of moss and lichen between; while in others a dense thicket of firs and shrubs covers a swamp or borders a rivulet.

The plants obtained from the south-west corner of Drummond Island were collected between the 31st July and 2nd August, and those from the south-east corner on the 4th August; while the collections from Sidgrave Cove, on the north side of the island, were made on the 9th August, and those from Vermont and Medford Harbours, on the north-west part, on the 30th and 31st August.

From the lake the aspect of the land on Drummond and Cockburn Islands is quite different. High land, covered with hard-wood, runs through the centre of Cockburn Island, which lies between Drummond and the Grand Manitoulin, having on the west side of it the False Detour Channel, and on the east the Straits of Mississagui. Towards the shore of the island, firs are most numerous. The whole of the forest on this island is much heavier than that of its more level neighbour. The eastern side of the island is undulating or hilly, the valleys running in a south-westerly direction. The most notable characteristic of the forest on this island is the quantity of red pine (*Pinus resinosa*) which occurs in it. Few of the trees seen of this species were very large, but in places they are very numerous (particularly in the bay to the east of the south-west point of the island), and large enough for making into timber for frames of houses.

Collections of plants were made in this island at the following dates:—South-west point of the island, August 6th; interior and north part of the island, August 6th and 7th; Thompson's Point, August 11th; Sandy Bay, north side, August 13th; McLeod's Harbour and Huronia Point, on the east side, August 21st; Little Cockburn Island, in the False Detour Channel, August 5th.

Cape Smyth, at the east end of the Grand Manitoulin Island, was visited on the 17th July, and Gore Bay, on the north side of the same island, on the 15th August. The forest south of Gore Bay resembles very much that of Cockburn Island. A good many white-pine trees were seen to the south-west of Gore Bay, and red pine occurs towards Lake Kagewong, and also at the west end of the island. Fires have passed through a large extent of the woods to the south and south-east of Gore Bay, killing the trees and causing them to fall. Lying across one another, two or three deep, the interspaces filled up with brushwood and a rank growth of willow-herb (*Epilobium angustifolium*), which always abounds in these *brulés*, these bare and charred trees form an almost impassable barrier to the explorer. The marsh at the foot of Gore Bay, and the high cliffs on its eastern side, afforded a number of rare plants.

Mississagui Island is small, flat, and sandy, with two marshy ponds in its centre, and lies to the north of the straits of the same name. Part of it is covered with trees, and the rest is made up of sand-reaches partially covered with vegetation. It was visited on the 22nd July.

William Island of the charts (locally known as Whiskey Island), at the mouth of Wequemakong Bay, east end of Grand Manitoulin, was touched at on July 18th and September 15th. This island, like many in the neighbourhood, is low and flat, and is all wooded, with the exception of an open sandy space at its western extremity, on which I

found several unusual species of plants, and which, from the bones scattered over its surface, may have been an Indian burying-place.

In these remote settlements the growth of foreign weeds seems to keep pace with the settlers, and even to outstrip them in their advances into the forests. This is to be regretted, as much might be done, by careful selection of seed-grain and other means, to exclude many noxious weeds from these new and isolated settlements.

To Professor Asa Gray, of Harvard University, I am much indebted for his kindness in determining the species of several of the plants in the following list :—

RANUNCULACEÆ.

1. *Clematis Virginiana*, L.—South of Gore Bay, Grand Manitoulin Island.
2. *Anemone multifida*, DC.—Drummond Island.
3. " *Virginiana*, L.—S. W. extremity of Cockburn Island, and at Sandy Bay, on the north side, Gore Bay, Grand Mnitoulin Island.
4. " *Pennsylvanica*, L.—Owen Sound, Mississagui Island, Bruce Mines, middle of St. Joseph Island, S. W., orner of Cockburn Island, Sidgrave's Cove, Drummond Island, Gore Bay.
5. *Hepatica triloba*, Chaix.—McLeod's Harbour, E. end Cockburn Island, Vermont Harbour, Drummond Island.
6. " *acutiloba*, DC.—Owen Sound.
7. *Thalictrum Cornuti*, L.—Owen Sound, Mississagui Island.
8. *Ranunculus aquatilis*, L., Var. *divaricatus*, Gray.—Owen Sound, Sandy Bay, N. side of Cockburn Island, Gore Bay.
9. " *Flammula*, L., Var. *reptans*, L.—Whiskey, or William Island, E. end of Grand Manitoulin Island, Mississagui Island, E. end of St. Joseph Island, Drummond Island, Gore Bay.
10. " *sceleratus*, L.—Owen Sound.
11. " *recurvatus*, Poir.—Owen Sound.
12. " *Pennsylvanicus*, L.—Little Current, Bruce Mines, centre of St. Joseph Island, S.W. corner of Cockburn Island, Gore Bay.
13. " *repens*, L.—Owen Sound, Sidgrave's Cove, Drummond Island, Gore Bay.
14. " *acris*, L.—Bruce Mines.
15. *Caltha palustris*, L.—Owen Sound, border of the lake in the centre of St. Joseph Island, Cockburn Island, Drummond Island.
16. *Coptis trifolia*, Salisb.—Hilton Village, or Town-plot, St. Joseph's Island, McLeod's Harbour, Cockburn Island.
17. *Aquilegia Canadensis*, L.—Owen Sound, Sidgrave's Cove, Drummond Island, McLeod's Harbour.
18. *Actæa spicata*, L., Var. *rubra*.—Owen Sound, Hilton Lake, centre of St. Joseph Island, Cockburn Island, Drummond Island.
    Var. *alba*.—Owen Sound.

NYMPHÆACEÆ.

19. *Nymphæa odorata*, Ait.—Sandy Bay, Cockburn Island.
20. *Nuphar advena*, Ait.—Owen Sound, Drummond Island, Thompson Point, N. side of Cockburn Island, McLeod's Harbour.

SARRACENIACEÆ.

21. *Sarracenia purpurea*, L.—Drummond Island, McLeod's Harbour, Cockburn Island.

PAPAVERACEÆ.

22. *Sanguinaria Canadensis*, L.—Centre of St. Joseph Island.

FUMARIACEÆ.

23. *Adlumia cirrhosa*, Raf.—Gore Bay. Growing thirty feet high.
24. *Corydalis aurea*, Willd.—Cockburn Island, S.W. corner; and at McLeod's Harbour, E. end.
25. " *glauca*, Pursh.—Richardson's, south side, St. Joseph Island, S. W. corner and McLeod's Harbour, Cockburn Island, Sidgrave's Cove, Drummond Island.

CRUCIFERÆ.

26. *Nasturtium officinale*, R. Br.—Owen Sound. Of large size, and growing in great quantities in a spring brook.
27. " *palustre*, DC.—Owen Sound, Whiskey Island, Missassagui Island, Bruce Mines.
28. *Dentaria diphylla*, L.—Owen Sound.
29. *Cardamine pratensis*, L.—Whiskey Island.
30. " *hirsuta*, L.—Cockburn Island, Owen Sound.
31. *Arabis lyrata*, L.—Cockburn Island.
32. *Turritis glabra*, L.—Whiskey Island.
33. " *stricta*, Graham.—Whiskey Island, Mississagui Island.
34. *Barbarea vulgaris*, R. Br.—Mississagui Island, Richardson's, S. side of St. Joseph Island, Cockburn, Drummond, and Whiskey Islands.
35. *Sisymbrium officinale*, Scop.—Owen Sound.
36. " *canescens*, Nutt.—Whiskey Island.
37. *Lepidium Virginicum*, L.—Owen Sound, Whiskey Island, Little Current.
38. *Capsella bursa-pastoris*, Moench.—Owen Sound, Bruce Mines.
39. *Cakile Americana*, Nutt.—Cockburn Island, S. W. point, and McLeod's Harbour.

VIOLACEÆ.

40. *Viola blanda*, Wild.—Middle of St. Joseph Island, McLeod's Harbonr, Cockburn Island.
41. " *Selkirkii*, Goldie?—McLeod's Harbour.
42. " *cucullata*, Ait.—Owen Sound, St. Joseph Island, Cockburn Island, Gore Bay.
43. " *rostrata*, Pursh?—Owen Sound.
44. " *Muhlenbergii*, Torr.—McLeod's Harbour.
45. " *Canadensis*, L.—Owen Sound, centre of St. Joseph Island.
46. " *pubescens*, Ait.—Owen Sound, Gore Bay, Vermont Harbour, Drummond Island

DROSERACEÆ.

47. *Drosera rotundifolia*, L.—Drummond Island, S.W. point, and McLeod's Harbour, Cockburn Island.
48. " *linearis*, Goldie.—In same localities as last.

PARNASSIACEÆ.

49. *Parnassia palustris*, L.—Drummond Island.
50. " *Caroliniana*, Michx.—McLeod's Harbour, Cockburn Island, Drummond Island.

HYPERICACEÆ.

51. *Hypericum mutilum*, L.—Mississagui Island, E. end of St. Joseph Island, Vermont Harbour, Drummond Island.
52. " *Kalmianum*, L.—Whiskey, Mississagui, Cockburn and Drummond Islands. Common on the shores.

53. *Elodea Virginica*, Nutt.—Mississagui Island, marsh near a small lake in the middle of St. Joseph Island, Thompson Point and McLeod Harbour, Cockburn Island.

CARYOPHYLLACEÆ.

54. *Silene antirrhina*, L.—Mississagui Island.
55. " *noctiflora*, L.—Bruce Mines, Hilton Village.
56. *Agrostemma Githago*, L.—Richardson's, S. side of St. Joseph Island.
57. *Alsine Michauxii*, Fenzl.—Drummond Island, S.W. point, and McLeod's Harbour, Cockburn Island.
58. *Arenaria serpyllifolia*, L.—Owen Sound, Sidgrave Cove, Drummond Island.
59. *Stellaria longifolia* Muhl.—Centre and S. side of St. Joseph Island.
60. " *borealis*, Bigelow.—Richardson's, St. Joseph Island.
61. *Cerastum viscosum*, L.—Bruce Mines, Hilton.
62. " *arvense*, L.—Drummond Island.

TILIACEÆ.

63. *Tilia Americana*, L.—Owen Sound, centre of St. Joseph Island, Cockburn Island, N. side Gore Bay, Vermont Harbour, Drummond Island.

OXALIDACEÆ.

4. *Oxalis acetosella*, L.—Owen Sound.
5. " *stricta*, L.—Owen Sound.

GERANIACEÆ.

6. *Geranium Robertianum*, L.—Owen Sound, Whiskey Island, Bruce Mines, Drummond and Cockburn Islands.

BALSAMINACEÆ.

7. *Impatiens fulva*, Nutt.—Mississagui, Drummond, Cockburn and St. Joseph Islands, Gore Bay.

ANACARDIACEÆ.

8. *Rhus typhina*, L.—Cape Smyth, E. end of Grand Manitoulin Island, Whiskey Island S.W. point, and McLeod's Harbour, Cockburn Island; Mississagui and Drummond Islands.
9. " *Toxicodendron*, L., Common.—Cape Smyth, McLeod's Harbour, Whiskey Island, Mississagui Island, S.W. points of Drummond and Cockburn Islands.
0. " *aromatica*, Ait.—Whiskey Island. Some years ago I collected this plant on Wolfe Island, opposite Kingston.

RHAMNACEÆ.

1. *Rhamnus alnifolius*, L'Her.—Drummond Island, Thompson Point and McLeod's Harbour, Cockburn Island.
2. *Ceanothus ovalis*, Bigelow—Gore Bay, Grand Manitoulin Island.—Growing abundantly near the edge of the cliff on the E. side of the bay, near its mouth.

CELASTRACEÆ.

3. *Celastrus scandens*, L.—Owen Sound.

SAPINDACEÆ.

74. *Acer Pennsylvanicum*, L.—Hilton, S.W. of Cockburn Island, Gore Bay, Vermo Harbour.
75. " *spicatum*, Lamb.—Owen Sound, Hilton, Cockburn Island, Gore Bay.
76. " *saccharinum*, Wang.—Owen Sound, Hilton, Cockburn Island, Gore Bay, V mont Harbour.
77. " *rubrum*, L.—Centre of St. Joseph Island, E. end of same island, S.W. point Cockburn Island, Gore Bay.

POLYGALACEÆ.

78. *Polygala Senega*, L.—Drummond Island, S.E. corner.
79. " *polygama*, Walt.—Drummond Island.
80. " *paucifolia*, Willd.—Cockburn and Drummond Islands.

LEGUMINOSÆ.

81. *Trifolium pratense*, L.—Cockburn Island, Owen Sound.
82. " *repens*, L.—Owen Sound, Bruce Mines.
83. *Astragalus Canadensis*, L.—E. end of Manitoulin Island.
84. " *Cooperi*, Gray.—Whiskey Island, Gore Bay.
85. *Lathyrus maritimus*, Bigelow.—Hilton, Mississagui Island.
86. " *palustris*, L.—Owen Sound, E. end of Grand Manitoulin Island, lake in t middle of St. Joseph Island, Sidgrave Cove, McLeo Harbour.
87. " *myrtifolius*, Muhl.—Cockburn Island, Gore Bay.
88. *Amphicarpœa monoica*, Nutt.—Owen Sound.

ROSACEÆ.

89. *Prunus Americana*, Marsh.—Whiskey Island.
90. " *pumila*, L.—Common on the shores of Whiskey, Mississagui, Drummond a Cockburn Islands.
91. " *Pennsylvanica*, L.—Mississagui Island, Hilton, Whiskey Island, S.W. poi and McLeod's Harbour, Cockburn Island, Sidgra Cove.
92. " *Virginiana*, L.—St. Joseph, Drummond, Mississagui, Cockburn, and Whisk (or William) Islands.
93. *Spiræa opulifolia*, L.—Whiskey, Mississagui, Drummond, and Cockburn Islands.
94. " *salicifolia*, L.—Mississagui Island.
95. *Agrimonia Eupatoria*, L.—Owen Sound, E. end of St. Joseph Island.
96. *Geum album*, Gmelin.—Owen Sound.
97. " *strictum*, Ait.—Owen Sound, Mississagui and Whiskey Islands, Hilton.
98. " *rivale*, L.—Owen Sound.
99. *Waldsteinia fragarioides*, Tratt.—Cockburn Island and Gore Bay.
100. *Potentilla Norvegica*, L.—Owen Sound, Mississagui Island, Hilton, Drummond a Cockburn Islands.
101. " *anserina*, L.—Owen Sound, Whiskey Island, Mississagui Island, Bru Mines, W. side of Drummond Island, Hilton, Cockbu Island, Sidgrave Cove.
102. " *fruticosa*, L.—Drummond and Cockburn Islands.
103. " *palustris*, Scop.—Mississagui Island, Bruce Mines, Drummond Island, side of Sidgrave Cove, Thompson Point.
104. *Fragaria Virginiana*, Ehrhart.—Hilton, Mississagui Island.
105. " *vesca*, L.—Owen Sound, Richardson's, St. Joseph Island.

106. *Dalibarda repens*, L ?—Gore Bay. Only the leaves could be found.
107. *Rubus odoratus*, L.—Middle of St. Joseph Island.
108. " *triflorus*, Richards.—Hilton, Owen Sound.
109. " *strigosus*, Mich.—Owen Sound, Mississagui Island, Bruce Mines, Hilton, Cockburn and Drummond Islands.
110. " *occidentalis*, L.—Owen Sound.
111. " *villosus*, Ait.—Owen Sound, Mississagui Island, Bruce Mines, Hilton.
112. *Rosa Carolina*, L.—Whiskey Island.
113. " *lucida*, Ehrhart.—Cape Smyth.
14. " *blanda*, Ait.—Mississagui Island, Cape Smyth, Whiskey Island, centre of St. Joseph Island, Drummond and Cockburn Islands.
15. " *stricta*, Lindl.—Whiskey Island.
16. *Cratægus crus-galli*, L.—Whiskey Island.
17. *Pyrus arbutifolia*, L.—Border of the lake in the centre of St. Joseph Island, Thompson Point, Cockburn Island.
18. " *Americana*, DC —Hilton, middle of St. Joseph Island, S.W. point of Cockburn Island.
19. *Amelanchier Canadensis*, Torrey & Gray.—Beside a lake in the middle of St. Joseph Island, S.W. point of Cockburn Island, Sidgrave Cove, Whiskey Island.

ONAGRACEÆ.

20. *Epilobium angustifolium*, L.—Very common and luxuriant throughout these islands, Owen Sound, Mississagui, Whiskey, Drummond and Cockburn Island, Bruce Mines. In the *brulés* or burnt woods S. of Gore Bay this plant grew to the height of six or seven feet, and was so rank and in such quantities as to make walking exceedingly difficult.
21. " *coloratum*, Muhl.—Gore Bay, W. end of Drummond Island, Hilton, Cockburn Island, Bruce Mines, Sidgrave Cove.
2. *Œnothera biennis*, L.—Owen Sound, Cape Smyth, Whiskey and Mississagui Islands, Sidgrave Cove, S.W. point of Cockburn Island.
3. " *pumila*, L.—Mississagui Island.
4. *Ludwigia palustris*, Ell.—Owen Sound.
5. *Circæa alpina*, L.—Owen Sound and Hilton.
6. *Myriophyllum spicatum*, L.—Sandy Bay.
7. *Hippuris vulgaris*, L.—Gore Bay, Vermont Harbour.

GROSULACEÆ.

8. *Ribes Cynosbati*, L.—Owen Sound.
9. " *hirtellum*, Michaux.—Mississagui, Cockburn and Drummond Islands, Gore Bay.
0. " *lacustre*, Poir.—Owen Sound, middle of St. Joseph Island, S.W. point, and McLeod's Harbour, Cockburn Island, Gore Bay.
1. " *prostratum*, L'Her.—Owen Sound, Gore Bay.
2. " *floridum*, L.—Owen Sound, Gore Bay.
3. " *rubrum*, L.—Gore Bay, Hilton, Owen Sound.

SAXIFRAGACEÆ.

4. *Mitella diphylla*, L.—Owen Sound.
5. " *nuda*, L.—Owen Sound, Hilton, Drummond Island.
6. *Tiarella cordifolia*, L.—Owen Sound.

UMBELLIFERÆ.

137. *Hydrocotyle Americana*, L.—Hilton.
138. *Sanicula Marilandica*, L.—Owen Sound, Sidgrave Cove.
139. *Heracleum lanatum*, Michx.—Mississagui Island.
140. *Pastinaca sativa*, L.—E. end of St. Joseph Island, W. side of Drummond Island.
141. *Cicuta maculata*, L.—Mississagui Island, S.W. part of Cockburn Island, Sidg Cove, Vermont Harbour.
142. *Osmorrhiza longistylis*, DC.—Owen Sound.
143. " *brevistylis*, DC.—Owen Sound, St. Joseph Island.

ARALIACEÆ,

144. *Aralia racemosa*, L.—Very rank in the middle of St. Joseph Island, Vermont, bour.
145. " *hispida*, Michx.—Mississagui Island, centre of St. Joseph Island, W. sid Cockburn Island.
146. " *nudicaulis*, L.—Owen Sound, Hilton, S.W. corner of Cockburn Island, grave Cove, Vermont Harbour, Cape Smyth, Mani lin Island, E. end.

CORNACEÆ.

147. *Cornus Canadensis*, L.—Owen Sound, Mississagui Island, Bruce Mines, Hilton, (Bay, Drummond and Cockburn Islands.
148. " *circinata*, L'Her.—Hilton, W. side of Drummond and Cockburn Isla Sidgrave Cove, Gore Bay.
149. " *sericea*, L.—Small island at E. end of St. Joseph, McLeod's Harbour.
150. " *stolonifera*, Michx.—Owen Sound, Whiskey and Mississagui Islands, W. of Drummond and Cockburn Islands, Sidgrave C McLeod's Harbour, Thompson Point, Gore Bay.
151. " *alternifolia*, L.—Gore Bay, Owen Sound.

CAPRIFOLIACEÆ.

152. *Linnæa borealis*, Gronov.—Mississagui Island, Bruce Mines, W. sides of Cock and Drummond Islands, interior of St. Joseph Isl
153. *Symphoricarpus racemosus*, Michx.—Cape Smyth, cliffs on the E. side of Gore Cockburn Island.
154. *Lonicera parviflora*, Lam.—Owen Sound, Mississagui Id., W. side Drummond Cockburn Isds., McLeod's Hbr., Sidgrave Cove.
155. " *hirsuta*, Eaton.—Sidgrave Cove, Owen Sound, Mississagui Id.
156. " *ciliata*, Muhl.—Owen Sound, Little Cockburn Id., Hilton, Thompson McLeod's Hbr., and W. side Cockburn Id.
157. " *oblongifolia*, Muhl.—Thompson Pt., Sidgrave Cove.
158. *Diervilla trifida*, Moench.—Owen Sound, Cape Smyth, Mississagui Id., Bruce M lake in centre of St. Joseph Id., McLeod's Hbr. S.W. corner Cockburn, Sidgrave Cove.
159. *Triosteum perfoliatum*, L.—Owen Sound.
160. *Sambucus Canadensis*, L.—Owen Sound.
161. " *pubens*, Mich.—Owen Sound, Hilton, and throughout St. Joseph Id., very abundant in some parts of the interior.
162. *Viburnum opulus*, L.—Gore Bay, Whiskey Isd.

RUBIACEÆ.

63. *Galium triflorum*, Michx.—Owen Sound, Mississagui Id., Bruce Mines, interior St. Joseph Id.
64. *Mitchella repens*, L.—Owen Sound.

DIPSACEÆ.

65. *Dipsacus sylvestris*, Mill.—Woodstock.

COMPOSITÆ.

66. *Eupatorium purpureum*, L.—Mississagui Id., interior and S. point St. Joseph Id., various places in Cockburn and Drummond Ids.
67. " *perfoliatium*, L.—Owen Sound, Whiskey Id., Mississagui Id., Bruce Mines, border of lake in interior St. Joseph Id., W. sides of Cockburn and Drummond Isds., McLeod's Hbr., Hay Pt., S. side St. Joseph Id.
68. *Nardosmia palmata*, Hook.—Drummond and Cockburn Isds.
69. *Aster macrophyllus*, L.—Cape Smyth, interior St. Joseph Id., W. side Cockburn Id., Sidgrave Cove, Vermont Hbr.
70.. *Aster cordifolius*, L.—Hay Point, Sidgrave Cove.
71. " *miser*, L. Ait.—Hay Point and interior St. Joseph Id., Vermont Hbr.
72. " *simplex*, Willd.—Bruce Mines, Vermont Hbr.
73. " *tenuifolius*, L.—Hay Point.
74. " *puniceus*, L.—Hay Point, Bruce Mines, Whiskey Id.
75 " *ptarmacoides*, Torr & Gr.—Cockburn Island.
76. *Erigeron Canadense*, L.—Bruce Mines, Hilton, Sidgrave Cove, Gore Bay, Cockburn Id.
77. " *Philadelphicum*, L.—Bruce Mines, Owen Sound, Hilton, Cockburn Id.
78. " *annuum*, Pers.—Owen Sound.
79. " *strigosum*, Muhl.—With last.
80. *Solidago virgaurea*, L.—McLeod's Hbr.
81. " *altissima*, L.—Bruce Mines.
82. " *Canadensis*, L.—Bruce Mines, Vermont Hbr., Hay Point.
83. " *gigantea*, Ait.—Whiskey Id.
84. " *lanceolata*, L.—Bruce Mines, Vermont Hbr., Hay Point.
85. " *Ohioensis*, Riddell.—Cockburn Id., W. side.
86. *Inula Helenium*, L.—Owen Sound.
87. *Rudbeckia hirta*, L.—Richardson's, St. Joseph Island.
88. *Coreopsis lanceolata*, L.—Rocky shore, McLeod's Hbr.
89. *Bidens chrysanthemoides*, Michx.—Gore Bay.
90. " *Beckii*, Torr.—Vermont Harbour.
91. *Maruta cotula*, DC.—Bruce Mines.
92. *Achillea mille-folium*, L.—William Id., Mississagui Id., Bruce Mines, W. side Cockburn Id., Sidgrave Cove, Var. *roseam*, Cockburn Id.
93. *Artemisia Canadensis*, Michx.—Cockburn, Mississagui, and Whiskey Ids., Bruce Mines.
94. *Gnaphalium polycephalum*, Michx.—Mississagui, Cockburn, and St. Joseph Isds., Bruce Mines, Owen Sound.
95. *Senecio aureus*, L.—Richardson's, W. side Drummond Id., Var. *oblongifolius*, Cockburn Id.
96. *Cirsium lanceolatum*, Scop.—Hilton.
97. " *Pitcheri*, Torr & Gr.—S.W. corner of Cockburn Id., near Little Cockburn Id.

198. *Cirsium discolor*, Spreng.—Owen Sound.
199. " *muticum*, Michx.—Hilton, small island S.E. of St. Joseph, Gore Bay.
200. " *pumilum*, Spreng.—Drummond and Cockburn Ids.
201. " *arvense*, Scop.—Hilton. Vars. *rubrum* and *album* growing close to t shore at Hilton, as if recently introduced.
202. *Lappa major*, Gærtn.—Owen Sound, Bruce Mines.
203. *Hieracium Canadense*, Michx.—Bruce Mines, W. side Cockburn Id.
204. *Nabalus albus*, Hook.—Gore Bay.
205. " *racemosus*, Hook.—Sandy Bay, Cockburn Id.
206. *Taraxacum dens-leonis*, Desf.—Owen Sound, Bruce Mines.
207. *Lactuca elongata*, Muhl.—Little Cockburn Id.
208. *Mulgedium leucophæum*, DC.—Owen Sound, Bruce Mines.

LOBELIACEÆ.

209. *Lobelia cardinalis*, L.—Lobelia Lake, centre of Cockburn Id.; McLeod's Hbr.
210. " *Kalmii*, L.—Mississagui Id., S.E. corner of St. Joseph Id., Sidgrave's Co McLeod's Hbr., and S.W. corner of Cockburn.

CAMPANULACEÆ.

211. *Campanula rotundifolia*, L.—Common on all the islands.
212. " *aparinoides*, Pursh.—Bruce Mines, border of lake in middle of St. Jose Id., Drummond Island, Gore Bay, Thompson's Poi McLeod's Hbr.

ERICACEÆ.

213. *Gaylussacia resinosa*, Torr & Gr.—Three miles N.W. of McLeod's Hbr.
214. *Vaccinium oxycoccus*, L.—Cockburn Id.
215. *Chiogenes hispidula*, Torr & Gr.—Drummond Id.
216. *Arctostaphylos uva-ursi*, Spreng.—Whiskey Id., Mississagui Id., Cockburn Id., M drum Bay, Grand Manitoulin Id.
217. *Epigæa repens*, L.—Drummond Id., W. side; Thompson Point, McLeod's Hbr.
218. *Gaultheria procumbens*, L.—Hilton.
219. *Cassandra calyculata*, Don.—Near the small lake in the interior of St. Joseph Id.
220. *Kalmia glauca*, Ait.—Drummond Id., Var. *rosmarinifolia*, Thompson Point.
221. *Ledum latifolium*, Ait.—W. end Drummond Id., McLeod's Hbr.
222. *Pyrola rotundifolia*, L.—McLeod's Hbr.
223. " *elliptica*, Nutt.—Owen Sound, Hilton, Gore Bay.
224. " *chlorantha*, Swartz.—Small island S.E. St. Joseph Id., corner Cockburn McLeod's Hbr., Gore Bay.
225. " *secunda*, L.—Owen Sound, Gore Bay, Hilton, Cockburn Id.
226. *Moneses uniflora*, Gray.—Near S. side St. Joseph Id.
227. *Chimaphila umbellata*, Nutt.—Mississagui Id., Hilton, Sidgrave Cove.
228. *Pterospora Andromeda*, Nutt.—N.W. point Drummond Id., on the wooded top o high cliff four miles S. of Gore Bay, Vermont Harb three miles N. of McLeod's Hbr. This plant grows great quantities in many places through the islands
229. *Monotropa uniflora*, L.—Hilton, Thompson Point, Gore Bay, Hay Pt., S.W. point Cockburn Id.
230. " *hypopitys*, L.—Thompson Pt., Core Bay.

AQUIFOLACEÆ.

231. *Ilex verticillata*, Gray.—Mississagui Id., beside the lake in centre St. Joseph Id. side of St. Joseph Id., Drummond Id. Thompson Poi McLeod's Hbr.

PLANTAGINACEÆ.

2. *Plantago major*, L.—Owen Sound, Gore Bay, Cockburn Id. In the interior of St. Joseph Id. I found several specimens of this plant with a small clasping leaflet half-way up the stalk of the spike, like that of a *Parnassia.*

PRIMULACEÆ.

3. *Primula farinosa*, L.—Whiskey Id., Mississagui, Drummond and Cockburn Isds.
4. *Trientalis Americana*, Pursh.—Hilton, S.W. point of Cockburn Id.
5. *Lysimachia stricta*, Ait.—Mississagui Id., border of lake, middle of St. Joseph Id.
6. *Naumburgia thyrsiflora*, Reichenb.—W. point Drummond Id.

LENTIBULACEÆ.

7. *Utricularia vulgaris*, L.—Vermont Hbr., Sandy Bay.
8. " *intermedia*, Hayne.—Growing on the muddy shore of a pond a mile W. of Huronia Pt., S. side of Cockburn Id.
9. " *cornuta*, Michx.—Mississagui Id., small island S.E. of St. Joseph Id., Cockburn Id.

SCROPHULARIACEÆ.

). *Verbascum Thapsus*, L.—Owen Sound, Bruce Mines, Hilton.
. *Mimulus ringens*, L.—Mississagui Id., Gore Bay, Owen Sound.
2. *Veronica Virginica*, L.—Gore Bay.
3. " *Americana*, Schwein.—Owen Sound, Hilton.
4. " *scutellata*, L.—Gore Bay.
. " *arvensis*, L.—Richardson's, S. side of St. Joseph Id.
. *Gerardia aspera*, Dougl.—Bay S. of Huronia Point.
. *Castilleia coccinea*, Spreng.—Common in many places in Drummond and Cockburn Isds., and conspicuous along the shore from its intensely bright scarlet flowers.
. *Melampyrum Americanum*, Michx.—Drummond and Cockburn Isds.

VERBENACEÆ.

. *Verbena hastata*, L.—Mississagui, St. Joseph and Cockburn Isds., Gore Bay.
. " *urticifolia*, L.—Between Owen Sound and Leith.
. *Phryma Leptostachya*, L.—On the S. side of the Pottawatamy River, Owen Sound.

LABIATÆ.

. *Mentha Canadensis*, L.—Mississagui Id., Bruce Mines, Hilton, Sidgrave Cove, Vermont Hbr., Little Cockburn Id.
. *Lycopus Europæus*, L.—Vars. *sinüatus* and *integrifolius*, Owen Sound, William, Drummond and Cockburn Isds.
. *Calamintha glabella*, Benth.—Var. *Nuttallii*, Gray. Common on the shores of Mississagui, Cockburn and Drummond Isds.
. " *clinopodium*, Benth.—Owen Sound, William (or Whiskey) Id., Wequemakong Bay, E. end of Grand Manitoulin, W. end of Drummond Id. and Sidgrave Cove.
. *Monarda fistulosa*, L.—Owen Sound.
. *Nepeta Cataria*, L.—Owen Sound, interior St. Joseph Id.
. *Prunella vulgaris*, L.—Common in all the Manitoulin group of islands.
. *Scutellaria parvula*, Michx.—Whiskey Id., Wequemakong Bay.

260. *Scutellaria galericulata*, L.—Whiskey Id., Mississagui Id., Bruce Mines, border lake in the interior of St. Joseph Id.
261. " *lateriflora*, L.—Cape Smyth, Bruce Mines, Mississagui and Cockbu Isds., Gore Bay.
262. " *versicolor*, Nutt ?.—Owen Sound, Hilton, S.W. point Cockburn Id.
263. *Galeopsis Tetrahit*, L.—Bruce Mines, Hilton.

BORRAGINACEÆ.

264. *Echinospermum Lappula*, Lehm.—Owen Sound, Sidgrave Cove.
265. *Cynoglossum officinale*, L.—Owen Sound, Bruce Mines, Hilton.
266. " *Morrisoni*, DC.—Owen Sound, Cape Smyth, Whiskey Id., middle of Joseph Id., Sidgrave Cove.

HYDROPHYLLACEÆ.

267. *Hydrophyllum Virginicum*, L.—Owen Sound.
268. " *Canadense*, L.—Owen Sound.

CONVOLVULACEÆ.

269. *Calystegia sepium*, R. Br.—McLeod's Harbour.

SOLANACEÆ.

270. *Solanum nigrum*, L.—Richardson's, St. Joseph Id., Vermont Hbr., N.W. corner Dru mond Id.
271. *Physalis viscosa*, L.—Gravelly bank S. W. corner Cockburn Id., Burnt Wood, G Bay.

GENTIANACEÆ.

272. *Halenia deflexa*, Griseb.—Mississagui and Drummond Isds.
273. *Gentiana detonsa*, Fries.—Drummond and Cockburn Isds. Not uncommon on shores.
274. " *saponaria*, L., var. *linearis*, Gray.—Bruce Mines.
275. *Menyanthes trifoliata*, L.—Marsh of Mississagui Id., S.W. corner of Drummond Thompson Point.

APOCYNACEÆ.

276. *Apocynum androsæmifolium*, L.—Owen Sound, Sidgrave Cove.
277. " *cannabinum*, L.—Whiskey Id.

ASCLEPIADACEÆ.

278. *Asclepias Cornuti* Decaisne.—Owen Sound.
279. " *incarnata*, L.—Whiskey Id., Thompson Point.

OLEACEÆ.

280. *Fraxinus Americana*, L.—Owen Sound, W. side and interior of Cockburn Isla Thompson Pt., McLeod's Hbr.
281. " *sambucifolia*, Lam.—H. Notthier, Cockburn Id.

ARISTOLOCHIACEÆ.

282. *Asarum Canadense*, L.—Owen Sound.

CHENOPODIACEÆ.

283. *Chenopodium album*, L.—Richardson's, Vermont Hbr.
284. *Blitum capitatum*, L.—Owen Sound, Little Current, interior of St. Joseph Id.

AMARANTACEÆ.

5. *Amaranthus paniculatus*, A.—Bruce Mines.

POLYGONACEÆ.

6. *Polygonum amphibium*, L.—Gore Bay, Vermont Harbour, Hay Point.
7. " *Pennsylvanicum*, L.—Sidgrave Cove.
8. " *persicaria*, L.—Mississagui Id., Hilton, Gore Bay.
9. " *hydropiper*, L.—Mississagui, Cockburn Id.
0. " *aviculare*, L.—Owen Sound, Bruce Mines.
1. " *ramosissimum*, Michx.—Drummond Id., Little Cockburn Id., Hay Point.
2. " *sagittatum*, L.—Bruce Mines.
3. *Rumex obtusifolius*, L —Owen Sound, Bruce Mines, St. Joseph Id.
4. " *crispus*, L.—Owen Sound, Bruce Mines, interior St. Joseph Id., Cockburn.
5. " *hydrolapathum*, (Hudson), var. *Americanum*, Mississagui Id., Owen Sound, Bruce Mines, Vermont Harbour.
6. " *acetosella*, L.—Mississagui Id., Bruce Mines, Hilton.

THYMELEACEÆ.

7. *Dirca palustris*, L.—Interior Cockburn Id., small Isd. off S.E. point St. Joseph.

ELŒAGNACEÆ.

8. *Shepherdia Canadensis*, Nutt.—Owen Sound, and common throughout these Islands

SANTALACEÆ.

9. *Comandra umbellata*, Nutt.—Whiskey and Mississagui Isds., Sidgrave Cove, S.W. Pt. Cockburn.

CALLITRICHACEÆ.

0. *Callitriche verna*, L.—Gore Bay.

URTICACEÆ.

1. *Ulmus fulva*, Michx.—Owen Sound, interior St. Joseph Id.
2. " *Americana*, L.—Sidgrave Cove, Gore Bay.
3. *Urtica gracilis*, Ait.—Owen Sound, Hilton.
4. *Laportea Canadensis*, Gaudich.—Owen Sound.

CORYLACEÆ.

5. *Quercus rubra*, L.—St. Joseph and Cockburn Ids.
6. *Fagus ferruginea*, Ait.—Hilton village and throughout St. Joseph Id., interior Cockburn Id., Gore Bay, Vermont Harbour.
7. *Corylus rostrata*, Ait.—Hilton, Cockburn Island,
8. *Ostrya Virginica*, Willd.—Hilton, interior Cockburn Id.

MYRICACEŒ.

9. *Myrica Gale*, L.—Mississagui, Drummond, Cockburn and St. Joseph Islands, Bruce Mines.

BETULACEÆ.

0. *Betula papyracea*, Ait.—Mississagui Id., Sidgrave Cove, Thompson Pt., Gore Bay S.W. Pt. and interior of Cockburn Id.
1. " *excelsa*, Ait.—Owen Sound, interior of St. Joseph and Cockburn Islds.
2. " *lenta*, L.—Hilton, Gore Bay.

313. *Alnus incana*, Willd.—Bruce Mines, Mississagui Id., Border of Lake St. Joseph Id McLeod's Hbr. and S.W. Pt. Cockburn.

SALICACEÆ.

314. *Salix candida*, Willd.—Common marshy grounds, St. Joseph, Cockburn and Drummond Isds.
315. " *cordata*, Muhl.—Sand reaches, S. side Cockburn Id.
316. " *pedicellaris*, Pursh.—Sand Bay.
317. *Populus tremuloides*, Michx.—Gore Bay, Mississagui Id., Mildrum Bay, St. Joseph Id., Sidgrave Cove, Vermont Hbr.
318. " *grandidentata*, Michx.—Gore Bay, St. Joseph, Cockburn and Drummond Id.
319. " *balsamifera*, L.—Same localities as last.

CONIFERÆ.

320. *Pinus resinosa*, Ait.—Common throughout Cockburn Id., Sidgrave Cove, Drummond Id., Gore Bay.
321. " *strobus*, L.—Mississagui, St. Joseph, Drummond, Cockburn Isds., Gore Bay
322. *Abies balsamea*, Marshall.—Mississagui Id., and on all the Manitoulin group.
323. " *Canadensis*, Michx.—St. Joseph Id., some trees three feet in diameter, Cockburn Id., Gore Bay.
324. " *nigra*, Poir.—Cockburn Id.
325. " *alba*, Mich.—Interior St. Joseph Id., northern part Cockburn Id., Gore Bay Whiskey Id.
326. *Larix Americana*, Michx.—Bruce Mines, S. end St. Joseph Id., Cockburn Id., McLeod Hbr., Vermont Hbr., Mildrum Bay.
327. *Thuja occidentalis*, L.—Common from the Grand Manitoulin Id. to Bruce Mines.
328. *Juniperus communis*, L.—Drummond Id., S. W. point and McLeod's Hbr., Cockburn Id.
329. " *Virginiana*, L. Var. *humilis*,—W. sides Drummond and Cockburn Isds.
330. *Taxus baccata*, L., Var. *Canadensis*, Gray.—Owen Sound, Mississagui Id., Hilton Little Cockburn Id., Gore Bay, Vermont Hbr.

ARACEÆ.

331. *Arisæma triphyllum*, Torr.—Owen Sound, St. Joseph Id.
332. *Calla palustris*, L.—Hilton.
333. *Acorus calamus*, L.—Gore Bay, Vermont Harbor.

TYPHACEÆ.

334. *Typha latifolia*, L.—Mississagui Id., S. end St. Joseph, Gore Bay.
335. *Sparganium ramosum*, Hudson.—Head of Gore Bay.
336. " *natans*, L., Var. *affine*, Fries.—Vermont Harbor.

NAIADACEÆ.

337. *Potamogeton pectinatus*, L.—Sandy Bay, N. side Cockburn Id.
338. " *Robbinsii*, Oakes.—Same place as last.
339. " *pusillus*, L.—With the above in a small sheltered nook of Sandy Bay
340. " *pauciflorus*, Pursh.—Gore Bay.
341. " *compressus*, L.—Hay Point.
342. " *perfoliatus*, L.—Sandy Bay.
343. " *lucens*, Var. *fluitans*, Roth.—Gore Bay.
344. " *heterophyllus*, Schreber.—Sandy Bay.

ALISMACEÆ.

45. *Triglochin maritimum*, L.—Drummond Id., McLeod's Hbr., Cockburn Id.
46. *Alisma Plantago*, L.—Owen Sound.
47. *Sagittaria variabilis*, Engelman, Vars. *gracilis*, *obtusa*, etc.—Owen Sound, Gore Bay, Little Cockburn Id.
48. " *calycina*, Engelm.—Growing at the entrance of a small creek at Gore Bay.

HYDROCHARIDACEÆ.

49. *Anacharis Canadensis*, Planchon.—Sandy Bay.
50. *Valisneria spiralis*, L.—Gore Bay, Vermont Hbr.

ORCHIDACEÆ.

51. *Platanthera obtusata*, Lindl.—St. Joseph and Drummond Isds.
52. " *orbiculata*, Lindl.—Hilton, Drummond Id., Cockburn Id.
53. " *hyperborea*, Lindl.—Lake interior St. Joseph Id., S.W. side Drummond Id., Thompson Pt., McLeod Hbr.
54. " *dilatata*, Lindl.—Drummond Id., W. side Thompson Pt.
55. " *psychodes*, Gray.—Owen Sound, Drummond Id., Thompson Pt., McLeod Hbr.
56. *Goodyera repens*, R. Br.—Sidgrave Cove, Thompson Pt., Gore Bay.
57. " *pubescens*, R. Br.—Interior St. Joseph Id., Thompson Point, Gore Bay.
58. *Spiranthes cernua*, Richard.—Drummond Id., McLeod's Hbr.
59. *Listera convallarioides*, Hook.—Hilton, W. side Cockburn Id.
60. *Corallorhiza multiflora*, Nutt.—Owen Sound, Cockburn Id.
61. *Cypripedium pubescens*, Willd.—Cockburn Id.
62. " *spectabile*, Swartz.—Thompson Pt.

IRIDACEÆ.

63. *Iris versicolor*, L.—Owen Sound, Mississagui Id., Bruce Mines, Cockburn Id.
64. *Sisyrinchium Bermudiana*, L.—Bruce Mines, Cockburn Id.

SMILACEÆ.

65. *Trillium cernuum*, L.—Interior St. Joseph Id., Gore Bay.
66. " *erectum*, L.—St. Joseph Id.
67. *Medeola Virginica*, L.—Owen Sound, Hilton.

LILIACEÆ.

68. *Polygonatum biflorum*, Ell.—Hilton.
69. *Smilacina racemosa*, Desf.—Owen Sound, Hilton, Gore Bay, McLeod Hbr.
70. " *stellata*, Desf.—Mississagui Id., West side and Sidgrave Cove, Drummond Id., Cockburn Id.
71. " *trifolia*, Desf.—Bruce Mines, Hilton, Thompson Pt., Gore Bay, McLeod Harbor.
72. " *bifolia*, Ker.—Mississagui Id., Cockburn Id.
73. *Clintonia borealis*, Raf.—Owen Sound, Mississagui and Cockburn Ids., Hilton.
74. *Allium tricoccum*, Ait.—Owen Sound.
75. *Lilium Philadelphicum*, L.—West side of Cockburn Id., McLeod's Hbr.

MELANTHACEÆ.

76. *Streptopus amplexifolius*, D. C.—Hilton.
77. " *roseus*, Michx.—Owen Sound, Hilton.
78. *Zygadenus glaucus*, Nutt.—Island Hbr., Drummond Id., Cockburn Id.

379. *Tofieldia glutinosa*, Willd.—Fairview Harbor, Drummond Id., Thompson Pt McLeod's Hbr.

PONTEDERIACEÆ.

380. *Pontederia cordata*, L.—Small S. E. corner St. Joseph Isd., Vermont Harbor.

ERIOCAULONACEÆ.

381. *Eriocaulon septangulare*, Withering.—Hay Point, S. side St. Joseph Isd. Ver abundant.

CYPERACEÆ.

382. *Scirpus acicularis*, L.—Gore Bay.
383. " *caspitosus*, L.—Thompson Pt.
384. " *pungens*, Vahl.—Hay Point.
385. *Eriophorum polystachyon*, L.—Mississagui Id.
386. " *gracile*, Koch.—Thompson Pt.
388. *Carex aurea*, Nutt.—Whiskey Id.

GRAMINEÆ.

388. *Zizania aquatica*, L.—Vermont Hbr.
389. *Panicum capillare*, L.—McLeod Hbr.

EQUISETACEÆ.

890. *Equisetum sylvaticum*, L.—S. W. side St. Joseph's Id, Gore Bay.
391. " *limosum*, L.—Owen Sound, Gore Bay, Hay Pt.
392. " *hyemale*, L.—Owen Sound, Gore Bay.
393. " *variegatum*, Schleicher.—Drummond Id., Cockburn Id., Gore Bay.
394. " *scirpoides*, Michx.—Hilton, Gore Bay, Drummond Id.

FILICES.

395. *Polypodium vulgare*, L.—Owen Sound, McLeod Hbr.
396. " *Phegopteris*, L.—Hilton.
397. " *Dryopteris*, L.—Owen Sound, Hilton.
398. *Struthiopteris Germanica*, Willd.—Owen Sound, Hilton, Gore Bay.
399. *Allosorus gracilis*, Presl.—McLeod Hbr.
400. *Pteris aquilina*, L.—Common from Owen Sound to the Bruce Mines.
401. *Adiantum pedatum*, L.—Owen Sound.
402. *Camptosorus rizophyllus*, Link.—Owen Sound.
403. *Scolopendrium officinarum*, Swartz.—Growing in rich soil among loose rocks, at th foot of a limestone escarpment, a short distance S.W of Owen Sound.
404. *Asplenium Trichomanes*, L.—Owen Sound, McLeod Hbr.
405. " *viride*, Hudson.—Owen Sound. Growing among the moss on the side of cool moist clefts or gorges in the limestone escarp ment mentioned above.
406. " *thelypteriodes*, Michx.—Interior St. Joseph Id.
407. " *Filix-fœmina*, R. Br.—Whiskey Id., St. Joseph Id., Sandy Bay, Gor Bay.
408. *Cystopteris bulbifera*, Bernh.—Common from Owen Sound to St. Joseph Id.
409. " *fragilis*, Bernt.—Owen Sound, Gore Bay, McLeod Hbr.
410. *Aspidium Noveboracense*, L. Willd.—Gore Bay.
411. " *spinulosum*, Swartz.—Owen Sound, Hilton.

12. *Aspidium cristatum*, Swartz.—Owen Sound.
13. " *marginale*, Swartz.—Owen Sound.
14. " *acrostichoides*, Swartz.—Owen Sound.
15. " *Lonchitis*, Spreng.—With *Scolopendrium officinarum.*—Owen Sound.
16. *Onoclea sensibilis*, L.—Owen Sound, Gore Bay, Hilton.
17. *Osmunda regalis*, L.—Border of Lake St. Joseph Id, Gore Bay, Thompson Pt., McLeod Hbr.
18. " *Claytoniana*, L., (*O. interrupta* Michx).—Hilton, St. Joseph's Id.
19. " *cinnamomea*, L.—Owen Sound.
20. *Botrychium lunarioides*, Swartz.—Owen Sound.
21. " *Virginicum*, Swartz.—Mississagui Id., St. Joseph and Cockburn Isds., Gore Bay.
22. " *simplex*, Gray.—Small Isd. E. end St. Joseph.

LYCOPODIACEÆ.

23. *Lycopodium lucidulum*, Michx.—Richardson's, S. side St. Joseph Isd.
24. " *annotinum*, L.—Same locality as last.
25. " *dendroideum*, Michx.—Same place.
26. " *clavatum*, L.—With the last and on Cockburn Id.
27. *Selaginella selaginoides*, Gray.—Fairview Cove, Drummond Isd.
28. " *apus*, Spreng.—Whiskey Isd., small Isd. E. end St. Joseph, Drummond and Cockburn Isds.

MUSCI.

29. *Climacium Americanum*, Bird.—St. Joseph Isd.
30. *Hypnum splendens*, Hedw.—Drummond Isd.
31. " *triquetrum*, L.—Island Hbr., Drummond Isd.
32. *Leucobryum glaucum*, Hampe.—Drummond Isd.

JUNGERMANNIACEÆ.

33. *Marchantia polymorpha*, L.—Owen Sound.

LICHENES.

34. *Cladonia rangiferina*,
35. *Cetraria Islandica*,
36. *Usnea barbata*,
37. " *jubata*,

} Island Harbor, Drummond Isd.

CHARACEÆ.

38. *Chara vulgaris*, L.—Gore Bay.

In the above list the initial letters and contractions after the names of the different ants, indicate the authors of the species. L. = Linnæus, DC. = DeCandolle, Poir. = Poiret, alisb. = Salisbury, Ait. = Aiton, Raf. = Rafinesque, Willd. = Willdenow, R. Br. = Robert rown, Scop. = Scopoli, Nutt. = Nuttall, Torr. = Torrey, Gr. = Gray, Michx. = Michaux, uhl. = Muhlenberg, L'Her. = L'Heritier. Lamb. = Lambert, Walt. = Walter, Gmel. = melin, Ehrh. = Ehrhart, Lindl. = Lindley, Ell. = Elliott, Gronov. = Gronovius, Mill. = iller, Hook. = Hooker, Pers. = Persoon, Spreng. = Sprengel, Benth. = Bentham, Griseb. = risebach, Desf. = Desfontaines, Wahl. = Wahlenberg, Bern. = Bernhardi, Hedw. = Hedwig, c.

Montreal General Hospital,
August, 1867.

COMMON AMERICAN NAMES OF THE PRECEDING PLANTS.

1. Virgin's bower.
2. Many-cleft anemone.
3. Tall anemone.
4. Pennsylvanian anemone.
5. Round-lobed hepatica.
6. Sharp-lobed "
7. Meadow rue.
8. White water-crowfoot.
9. Spear wort.
10. Cursed crowfoot.
11. Hooked "
12. Bristly "
13. Creeping "
14. Buttercups.
15. Marsh marigold.
16. Three-leaved goldthread.
17. Wild columbine.
18. Red bane-berry.
19. Sweet-scented water-lily.
20. Yellow pond-lily
21. Pitcher plant.
22. Blood-root.
23. Climbing fumitory.
24. Golden corydalis.
25. Pale corydalis.
26. Water-cress.
27. Marsh–cress.
28. Toothwort, pepper-root.
29. Cuckoo-flower.
30. Common bitter-cress.
31. Rock-cress.
32. Long-podded tower mustard.
33. Straight tower mustard.
34. Winter-cress, yellow-rocket.
35. Hedge mustard.
36. Tansy mustard.
37. Wild pepper-grass.
38. Shepherd's-purse.
39. American sea-rocket.
40. Sweet white violet.
41. Selkirk's violet.
42. Common blue violet.
43. Long-spurred violet.
44. American dog-violet.
45. Canada violet.
46. Downy yellow violet.
47. Round-leaved sundew.
48. Narrow-leaved sundew.
49. Common grass of Parnassus.
50. Larger grass of Parnassus.
51. Small flowered St. John's-wort.
52. Kalm's St. John's-wort.
53. Marsh St. John's-wort.
54. Sleepy catch-fly.
55. Night-flowering catch-fly.
56. Corn-cockle.
57. Sandwort.
58. Thyme-leaved sandwort.
59. Stitchwort.
60. Northern chickweed.
61. Larger mouse-ear chickweed.
62. Field chickweed.
63. Basswood, linden.
64. Wood-sorrel.
65. Sheep-sorrel.
66. Herb Robert.
67. Spotted touch-me-not.
68. Staghorn sumach.
69. Poison ivy, poison oak.
70. Fragrant sumach.
71. Buckthorn.
72. Oval leaved New Jersey tea.
73. Wax-work, climbing bitter-sweet.
74. Striped maple.
75. Mountain maple.
76. Sugar maple.
77. Red or swamp maple.
78. Seneca snake-root.
79. Rosy milk-wort.
80. Flowering wintergreen.
81. Red clover.
82. White clover.
83. Milk vetch.
84. Cooper's vetch.
85. Beach pea.
86. Marsh vetchling.
87. Myrtle-leaved vetchling.
88. Hog pea-nut.
89. Wild yellow plum, red plum.
90. Sand cherry.
91. Wild red cherry.
92. Choke cherry.
93. Nine bark.
94. Common meadow-sweet.
95. Common agrimony.
96. Avens.
97. Straight yellow avens.
98. Water or purple avens.
99. Barren strawberry.
100. Cinquefoil.
101. Silver-weed.
102. Shrubby cinquefoil.
103. Marsh five-fingers.
104. Strawberry.
105. Long stalked strawberry.
106. Dalibarda.
107. Purple flowering raspberry.
108. Dwarf raspberry.
109. Wild red raspberry.
110. Black raspberry, thimbleberry.
111. Common or high blackberry.
112. Swamp rose.
113. Dwarf wild rose.
114. Early wild rose.
115. Wild rose.
116. Cockspur thorn.
117. Choke-berry.
118. American mountain ash.
119. June berry, shad-bush, service-berry.
120. Great willow-herb.
121. Common small willow-herb.
122. Common evening primrose.
123. Small evening primrose.
124. Water purslane.

125. Nightshade.
126. Milfoil.
127. Mares-tail.
128. Wild gooseberry.
129. Smooth wild gooseberry.
130. Swamp gooseberry.
131. Field currant.
132. Wild black currant.
133. Red currant.
134. Mitre-wort, bishop's cap.
135. Little round-leaved ground ivy.
136. False mitre-wort.
137. Marsh penny-wort.
138. Sanicle, black snake-root.
139. Cow parsnip.
140. Common parsnip.
141. Spotted cowbane, musquash-root.
142. Smoother sweet cicely.
143. Hairy sweet cicely.
144. Spikenard.
145. Bristly sarsaparilla, wild elder.
146. Wild sarsaparilla.
147. Dwarf cornel, bunch-berry.
148. Round-leaved cornel.
149. Silky cornel, kennikennik.
150. Red-osier dogwood.
151. Alternate leaved-cornel.
152. Twinflower.
153. Snowberry.
154. Small honeysuckle.
155. Hairy honeysuckle.
156. Fly honeysuckle.
157. Swamp fly-honeysuckle.
158. Bush honeysuckle.
159. Fever-wort.
160. Common elder.
161. Red-berried elder.
162. Cranberry-tree.
163. Sweet-scented bedstraw.
164. Partridge-berry.
165. Wild teasel.
166. Joe-pye weed, trumpet weed.
167. Thoroughwort, bone-set.
168. Sweet colts-foot.
169. Large-leaved aster,
170. Heart-leaved aster.
171. Dwarf aster.
172. Simple aster.
173. Thin-leaved aster.
174. Showy marsh aster.
175. Sneeze-wort aster.
176. Horse-weed, butter-weed.
177. Fleabane.
178. Daisy fleabane, sweet scabious.
179. Daisy fleabane.
180. Golden-rod.
181. "
182. "
183. "
184. "
185. "
186. Elecampane.
187. Cone-flower.
188. Coreopsis.
189. Bur marigold.
190. Water marigold.
191. Common may-weed.
192. Yarrow milfoil.
193. Canada wormwood.
194. Common everlasting.
195. Golden ragwort, squaw-weed.
196. Common thistle.
197. Pitcher's woolly thistle.
198. Copse thistle.
199. Swamp thistle.
200. Pasture thistle.
201. Canada thistle.
202 Burdock.
203 Canada hawkweed.
204. White lettuce.
205. Hawk-weed, rattles-nake root,
206. Dandelion.
207. Wild lettuce.
208. False blue lettuce.
209. Cardinal flower.
210. Kalm's lobelia.
211. Harebell.
212. Marsh bellflower.
213. Black huckle-berry.
214. Small cranberry.
215. Creeping snowberry.
216. Bearberry.
217. Trailing arbutus, ground laurel.
218. Aromatic wintergreen.
219. Leather-leaf.
220. Swamp laurel.
221. Labrador tea.
222. Round-leaved pyrola.
223. Shin-leaf.
224. Small pyrola.
225. One-sided pyrola.
226. One-flowered pyrola.
227. Prince's pine, pipsissewa.
228. Pine-drops.
229. Indian pine.
230. Pine-sap, false beech drops.
231. Black alder winterberry.
232. Common plaintain.
233. Bird's eye primrose.
234. Chick wintergreen.
235. Loosestrife.
236. Tufted loosestrife.
237. Great bladderwort.
238. Intermediate bladderwort.
239. Horned bladderwort.
240. Common mullein.
241. Monkey flower.
242. Culver's-root, culver's physic.
243. American brooklime.
244. Marsh speedwell.
245. Corn speedwell.
246. Rough gerardia.
247. Scarlet painted-cup.
248. Cow-wheat.
249. Blue vervain.
250. Nettle-leaved or white vervain.
251. Lopseed.
252. Wild mint.
253. Water horehound,

254. Calamint.
255. Basil.
256. Wild bergamot.
257. Cat-mint, catnip.
258. Heal-all, self-heal.
259. Skullcap.
260. Common skullcap.
261. Mad-dog skullcap.
262. Skullcap.
263. Hemp-nettle.
264. Stick-seed.
265. Hounds-tongue.
266. Beggar's lice.
267. Waterleaf.
268. Canadian water-leaf.
269. Hedge bindweed.
270. Common nightshade.
271. Ground cherry.
272. Spurred gentian.
273. Smaller fringed gentian.
274. Soapwort gentian.
275 Buckbean.
276. Spreading dogbane.
277. Indian hemp.
278. Milkweed.
279. Swamp milkweed.
280. White ash.
281. Black ash, water ash.
282. Wild ginger.
283. Lamb's quarters, pigweed.
284. Strawberry blite.
285. Prince's feather.
286. Water persicaria.
287 Pennsylvanian persicaria.
288. Lady's thumb.
289. Smartweed.
290. Knotgrass, goose-grass.
291. Branching joint-weed.
292. Arrow-leaved tear-thumb.
293. Bitter dock.
294. Curled dock
295. Great water-dock.
296. Field or horse-sorrel.
297. Leatherwood, moosewood.
298. Shepherdia.
299. Bastard toadflax.
300. Vernal water star-wort.
301. Slippery or red elm.
302. American or white elm.
303. Tall wild nettle.
304. Wood nettle.
305. Red oak.
306. American beech.
307. Beaked hazlenut.
308. Hop hornbean, lever-wood, iron-wood.
309. Sweet gale.
310. Paper birch, canoe birch.
311. Yellow birch.
312. Cherry birch, sweet or black birch.
313. Speckled or hoary alder.
314. Hoary willow.
315. Heart-leaved willow.
316 Stalk-fruited willow.
317. American aspen.
318. Large-toothed aspen.
319. Balsam poplar, tacamahac, balm-of-gilead poplar.
320. Red pine.
321. White pine.
322. Balsam fir.
323. Hemlock spruce.
324. Black or double spruce.
325. White or single spruce.
326. Tamarack, American or black larch, hac matack.
327. Arbor vitæ, white cedar.
328. Juniper.
329. Red cedar, savin.
330. American yew, ground hemlock.
331. Indian turnip.
332. Water arum.
333. Sweet flag, calamus.
334. Cat-tail flag.
335. Branching bur-reed.
336. Floating bur-reed.
337. Comb pondweed.
338. Robbin's pondweed.
339. Slender pondweed.
340. Few-flowered pondweed.
341. Flat pondweed.
342. Shield-leaf pondweed.
343. Shining-leaved pondweed.
344. Clayton's pondweed.
345. Arrowgrass.
346. Water plantain.
347. Variable arrow-head.
348. Small northern arrow-head.
349. Waterweed.
350. Tape grass, eel grass.
351. Dwarf orchis.
352. Large round-leaved orchis.
353. Northern green orchis.
354. Northern white orchis.
355. Small purple-fringed orchis.
356. Rattlesnake plantain.
357. " "
358. Ladies' tresses.
359. Northern tway-blade.
360. Coral-root.
361. Large yellow lady's slipper.
362. Small yellow lady's slipper.
363. Large blue flag.
364. Blue-eyed grass.
365. Nodding trillium, wake robin.
366. Purple trillium, birth-root.
367. Indian cucumber-root.
368. Smaller Solomon's seal.
369. False spikenard.
370. Star lily.
371. Three-leaved smilacina.
372. Two-leaved smilacina.
373. Northern clintonia.
374. Wild leek.
375. Wild orange lily.
376. Smooth green twisted stalk.
377. Rosy flowered twisted stalk.
378. Zygadene.
379. False asphodel.
380. Pickerel-weed.
381. Pipewort.

382. Bulrush.
383. "
384. "
385. Many-stemmed cotton-grass.
386. Graceful cotton-grass.
387. Cane, sedge.
388. Indian rice, water-oats.
389. Panic-grass.
390. Wood horsetail.
391. Swamp horsetail.
392. Shave-grass, scouring rush.
393. Variegated scouring rush.
394. Small wood rush.
395. Common polypo
396. Marsh polypody.
397. Woodland polypody.
398. Ostrich fern.
399. Rock brake.
400. Common brake.
401. Maiden-hair.
402. Walking-leaf fern.
403. Hart's tongue.
404. Spleenwort.
405. Green spleenwort.
406. Silvery spleenwort.
407. Spleenwort.
408. Bladder fern.
409. Variable bladder fern.
410. Wood-fern, shield-fern.
411. Wood-fern, shield-fern.
412. "
413. "
414. Wood-fern, "
415. "
416. Sensitive fern.
417. Flowering fern.
418. Interrupted flowering-fern.
419. Cinnamon fern.
420. Moonwort.
421. Virginian moon-wort.
422. Simple leaved moon-wort.
423. Shining club-moss.
424. Club-moss.
425. Ground pine.
426. Common club-moss.
427. Club-moss selaginella.
428. Mossy "
429. Moss.
430. "
431. "
432. "
433. Liver-wort.
434. Reindeer moss.
435. Iceland moss.
436. Lichen.
437. "
438. Common chara.

POSTSCRIPT

BY

SIR W. E. LOGAN, F.R.S.,

ADDRESSED TO

ALFRED R. C. SELWYN, Esq.

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

MONTREAL, 1*st July*, 1870.

SIR,—Having been absent from Canada between the end of March and the latter part of June, I had not, until lately, an opportunity of perusing Mr. Robert Bell's Report on the Nipigon country. His explorations there were entered on by my instructions, and prosecuted while I was still director of the Geological Survey, and as I thus feel myself responsible for his work, I am desirous of making a few remarks regarding it.

R. Bell's report.

Mr. Bell's Report was printed, and Mr. Bell had started on his present season's investigations, before my return to Canada, and my remarks must therefore appear as a postscript to the General Report you are about to transmit in a printed form to the Government.

The explorations of Mr. Bell and his party have greatly extended our knowledge of the country to the north of Lake Superior, both in a topographical and a geological point of view, and important results are likely to follow. These gentlemen have displayed much perseverance in going over a large extent of ground, and determining its main features, the principal one of which, geographically, is the large lake which empties into Nipigon Bay. On being mapped to scale, however, the area of this lake does not appear to be by any means so great as was at first anticipated, nor does its magnitude seem to have been understated by previous explorers.

T. W. Herrick's plan.

On a plan of the north shore of Lake Superior, resulting from Mr. T. W. Herrick's explorations, and published in the Report of the Crown Land Commissioner in 1863, the estimated dimensions of the lake are said to be between 100 and 200 miles in length, by about sixty miles in breadth. With the aid of this plan, but limiting the dimensions of the lake by geo-

Map compiled by R. Barlow.

graphical features represented on a map of Lake Superior published in 1832 by the Society for the Diffusion of Useful Knowledge, Mr. R. Barlow, topographical draughtsman to the Geological Survey, several years ago came very near the truth both as to the size and position of the lake, in delineating it on the map compiled by him and published in 1866, on the scale of twenty-five miles to the inch, for the geological purposes of the Survey. As represented by Mr. Barlow, Lake Nipigon is very little different in size from that which the protraction of Mr. Bell's measurements makes it now.

Bell's map a sketch.

Considering the great extent of the shore-line of Lake Nipigon and the comparatively short time employed in surveying it, there must unavoidably be a great number of parts which have been only approximatively determined; the map must therefore for the present be considered no more than a sketch, of which the details may be improved hereafter as occasion may serve.

Height of Lake Nipigon over Lake Superior.

At the time of my departure in March the height of Lake Nipigon above Lake Superior was estimated by Mr. Bell at about 150 feet, and it was so represented by him in various lectures and in conversations with members of parliament and others; but I now find it stated in the Report to be 313 feet. In the absence of Mr. Bell it is difficult for me to imagine the reason of this difference. Two aneroid barometers were supplied him for the purpose of determining heights, and the greater height is that resulting from the readings of the instruments for the three principal ascents, amounting to $263\frac{1}{2}$ feet, with an estimated height of $49\frac{1}{2}$ feet for the remainder, consisting of thirteen separate slopes. The height as now given much more nearly approaches that published by Mr. S. J. Dawson, founded on the observations of Mr. Armstrong, and an apology is due to all those who may have been misled by Mr. Bell's mistake.

Unconformable trap.

In the geological branch of his investigations, Mr. Bell has carried the Upper Copper-bearing rocks of Lake Superior much farther north than they were previously determined. He appears to have ascertained that the great trappean overflows between Pigeon River and the Battle group of islands, rest unconformably upon the outcrop of the slates and the succeeding variegated sandstones, conglomerates and marls through which they have been poured, and occupy a gap or depression in the range of the Laurentian and Huronian rocks.

Question of Triassic age.

On lithological grounds alone Mr. Bell expresses the opinion that these volcanic products are of Triassic age. This opinion was long ago insisted on by Mr. Marcou, and no doubt lithological character is entitled to weight, when structural evidence cannot be brought to bear; but I am desirous of guarding you against the supposition that there is no such evidence in the present case, tending to carry the age of these rocks in a

ontrary direction. An allusion has already been made to this evidence n the *Geology of Canada*, p. 85.

From the western extremity of Lake Superior the trappean strata ppear to strike eastward with considerable regularity for 300 miles, until hey pass Michipicoten Island and reach the eastern coast. Here the trike suddenly changes to a bearing at right angles to its previous course, vith an upward slope to the eastward sufficiently rapid to bring an estinated thickness of at least 10,000 feet to the surface at Mamainse, in no ery great distance across the measures. This sudden change of strike, nd its accompanying phenomena have much the aspect of a great dislocaion, or it may be a great undulation. Its effects are apparent for nearly hundred miles along the east coast of the lake, and at the extremity of Gros Cap, are visible to within a few miles of the base of a series of ower Silurian fossiliferous limestones and shales. These Lower Silurian ocks, in a comparatively undisturbed condition, strike across the bearing of his great disturbance, and are followed by a series of palæozoic strata, ncluding Middle and Upper Silurian, Devonian and Carboniferous, belongng to the Michigan trough, all in a like condition, and apparently free om trappean intrusions.

Evidence of Lower Silurian age.

Sudden change of strike E. side of L. Superior.

If the trappean rocks of Lake Superior were post-Carboniferous, it ould be a startling fact that a series of rocks older than the traps hould cross the line of such a great disturbance in these, and approach so ear, without the smallest effect being produced upon the inferior strata; nd this alone would challenge a very rigid examination before allowing e traps to be of Triassic age.

According to the late Dr. Houghton, in his Report of 1840, as State eologist of Michigan, sandstones are seen to rise at a low angle from eneath limestones near Nebish rapids. These limestones are fossiliferous, nd are part of the Lower Silurian series to which allusion has just been ade. They here lie in the strike of similar limestones, observed by Ir. Murray in 1860, on St. Joseph Island, where, as well as in an outing patch on Campement d'Ours, dipping at the same low angle as before, ey contain an abundance of well marked Birdseye and Black River ssils, and where they rest upon eighty feet of similar sandstones, which e supported by Huronian strata. There does not appear to be any asonable doubt that these nearly horizontal sandstones belong to the me series as those at Sault Ste. Marie rapids, and that they extend to the ot of Gros Cap Mountain; passing thence to Point Iroquois, White-fish oint and Isle du Parisien. To the eastward of this island Mr. Murray presents them in a narrow strip, leaning against the Laurentian gneiss a moderate angle, and stretching seven miles along the south side of oulais Bay; also as forming the township of Kars and the chief part of the

Sault Ste. Marie sandstones.

Birdseye and Black River formation.

Murray's distribution of sandstones.

promontory between Goulais and Bachehwahnung Bays. He represents the large island in the latter bay, and the coast to the north of it as composed of them, with a conformable conglomerate beneath, while on the mainland amygdaloidal trap rocks appear beyond them in several places, resting on Laurentian gneiss and dipping westward at considerable angles. But in the neighbourhood of Ance aux Crêpes, on the south side o Mamainse promontory, older sandstones, in a disturbed condition, appear t be confusedly mixed up with the trap.

Macfarlane's section of Mamainse.

Mr. Macfarlane carefully examined the rocks of Mamainse promontor for the Survey, in 1866, and in his Report to me, at pp. 132-137, will b found what he has said of them. He roughly measured by pacing th beautiful section, which I had previously estimated as at least 10,000 fee thick, and separating it into forty-nine described masses, he raises th whole volume to 16,208 feet, of which 2137 feet are conglomerates, th rest being various kinds of igneous rocks. After various descriptiv details, regarding lithological peculiarities and the conflict of sedimentar and eruptive masses, Mr. Macfarlane says:—

"From what has been stated above it would appear that there is, at several points evidence of the existence of a sandstone of greater age than the bedded traps and con glomerates, and it would appear not unreasonable to suppose that it belongs to th lower group of the Upper Copper-bearing series. You have however pointed ou (Geology of Canada, p. 85) that there are extensive areas of almost horizontal sand stones on the east shore, whose indicated dip, and freedom from intersecting trap dyke "seem to support the suspicion that they overlie unconformably those rocks which associated with trap, constitute the Upper Copper-bearing series." In confirmation o the opinion you have expressed, I have to report that at a point to the south of Point aux Mines, where the Mamainse series adjoins the Laurentian rocks, the lowest membe of the former is unconformably overlaid by thin bedded bluish and yellowish-grey sand stones striking N. 50° E. and dipping 18° north-westward. The lowest layer is a con glomerate with granitic and trappean boulders, and a bluish fine grained and shal matrix. It is about six feet thick, and is followed by thirty feet of thin bedded sand stones, some parts of which might yield good flagstones. Some of the surfaces of thes are very distinctly ripple-marked. Above these come thin, shaly, rapidly disintegrat ing layers, in which are spheroidal concretions from five to ten inches in diameter. I is not possible to ascertain the total thickness of these sandstones, since they descen beneath the level of the lake. They are similar in lithological character to the sand stones which occur on the north side of Pointe aux Mines."*

Unconformable upper sandstones.

These upper unconformable sandstones, there appears to me no reason able doubt, are Mr. Murray's upper rocks from Mamainse to Gros Cap, an from Gros Cap to Nebish and Campment d'Ours; and it will thu readily be inferred from what has been said, that the reason why the tilte rocks of the Mamainse section, with a vertical thickness of over thre miles, so suddenly disappear in their progress towards the Lower Siluria rocks to the south, is that they run under these unconformably.

* For the relation of the Pointe aux Mines sandstones to 3,000 feet of trappea rocks there, see Geology of Canada p. 82.

In the northern peninsula of Michigan the Sault Ste. Marie sandstones appear to run along the south shore of Lake Superior, parallel with the fossiliferous limestones, for 150 miles, and gradually to turn to the south-westward from the neighbourhood of Marquette, as if following the rim of the Michigan trough to which they probably belong. Farther to the west, the rocks of Keewenaw promontory are represented as constituting an anticlinal form, having sandstones on each side, with traps and conglomerates between. As will be seen from the following remarks by Professor Hall, a fossiliferous limestone equivalent to that of Campment d'Ours rests on the sandstone on the south side of the anticlinal.

Birdseye and Black River limestones on S. side of Keewenaw Point.

"In 1846, Mr. C. C. Douglas discovered a fossiliferous magnesian limestone, resting upon sandstone, on the south side of Keewenaw Point in a line between the head of the bay and the mouth of Misery River. In 1848 or 1849 Messrs. J. W. Foster and J. D. Whitney brought from this locality several species of fossils, which were submitted to the examination of the writer. The geologists of Michigan represent that the same sandstone at Grand Island is succeeded by a fossiliferous limestone, which is doubtless that of the Keewenaw Point. The character of the fossils from the locality on Keewenaw Point is such as to leave no doubt that the limestone is equivalent to the Buff limestone of Wisconsin, holding the identical fossils, and representing the Birdseye and Black River limestones.*"

Fossils in the sandstone.

From the sandstone itself on the south shore of Lake Superior the only fossils obtained are a *Lingula*,† collected by Mr. Forest Shepherd in Tequamenen Bay, which Hall compares with a Calciferous species, and a *Pleurotomaria* § obtained by Mr. Murray near Marquette, which Mr. Billings compares with *P. Laurentina* of the Calciferous, but states to resemble also *P. aperta* of the Birdseye and Black River formation.

This concurrent testimony from different observers of the south shore of Lake Superior, you will perceive all points one way, and apparently shews a wide extent of the sequence indicated near the exit of the lake. What the structural evidence north of the lake may be, remains to be ascertained. Should the unconformable overlying trap support the supposed Upper Silurian rocks of the northern country, the north and south evidence would agree. Should the trap rest on the Upper Silurian rocks, the inference would be, unless the evidence on the south can be explained away, that there are two trappean periods, one Lower Silurian or pre-Silurian, and the other post-Silurian. But it is not the duty of the Geological Survey to predict what the age of the northern trappean rocks may be, but to investigate the evidence carefully and state it impartially.

I have the honor to be, Sir,

Your most obedient servant,

W. E. LOGAN.

* Hall, Supplementary Notes on the Potsdam sandstone; XVIth Report of the Regents of the University of the State of New York, p. 215.

† Hall, same report, note p. 214. § Geo. Can. p. 86.


MAP
OF THE
THUNDER BAY
&
LAKE NIPIGON REGIONS

PIE ISLAND
NEEBING
PAIPOONGE
Thompson I.
Pigeon Bay
Fort William
Pt. Arthur's Landing
Thunder Bay Mine
White Fish L.

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